CHEMICAL & METALLURGICAL ENGINEERING

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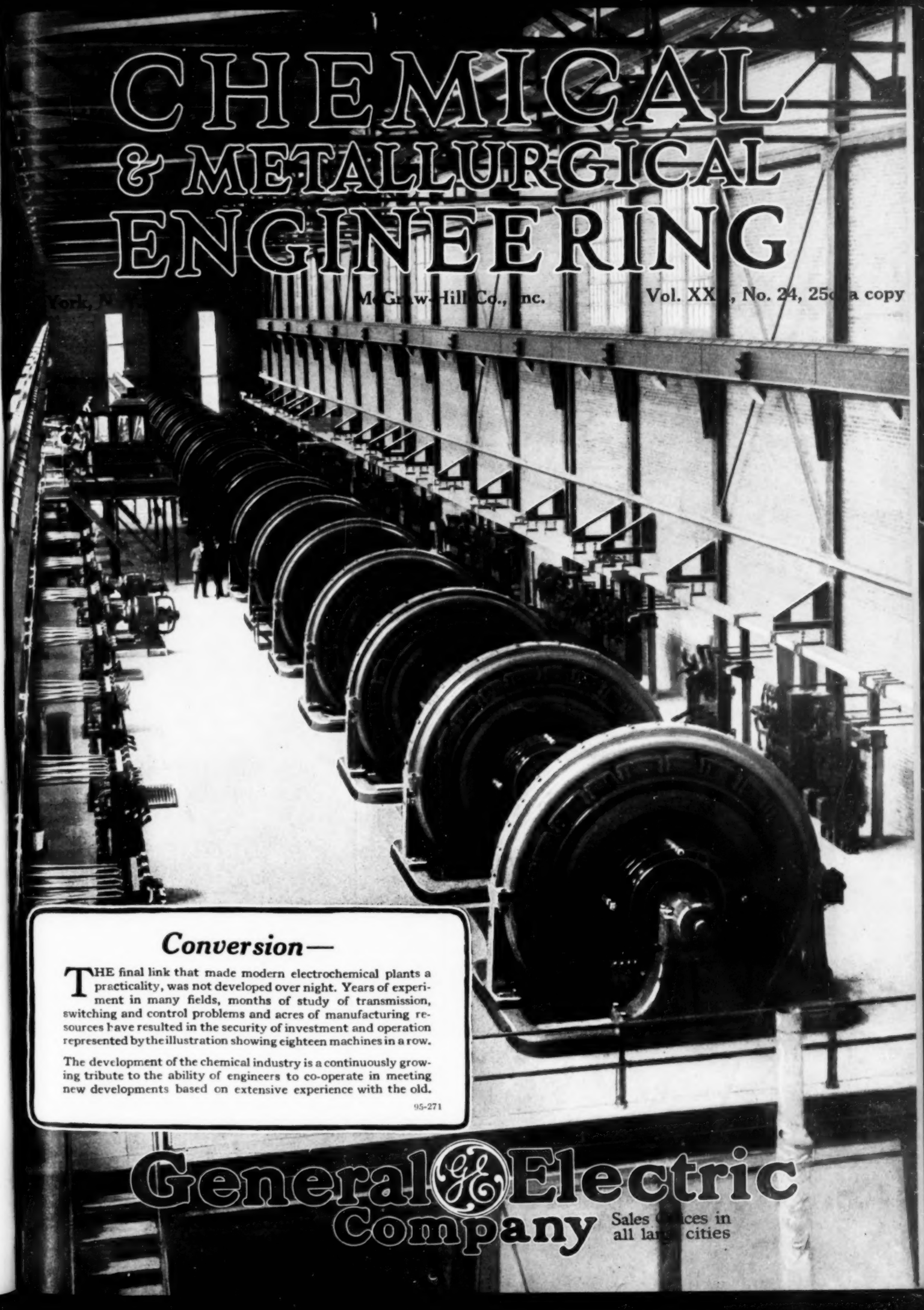

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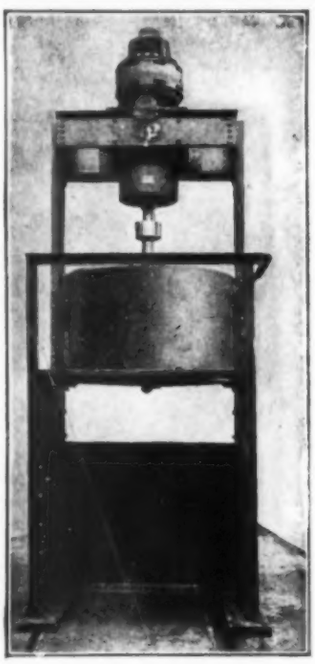

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And the Mountain Labored And Brought Forth—Harding

HERBERT HOOVER, was not nominated for President by the Republicans at Chicago last week. Instead the country was treated to an anticlimax in political affairs the like of which has not been witnessed in a generation. We claim no astuteness as political observers or prophets, but it requires no seventh son of a seventh son or veiled seer to detect the machinations of the Old Guard in determining for the members of a great political party their nominee for the Presidency. It would be to laugh were it not so pitifully tragic. And had better material been lacking, the mediocrity of the successful candidate would not have been so painfully evident as it now is by contrast with the superiority of some of his opponents.

The *dénouement* is the best argument yet produced for some device that will enable the American people to select a President with some consideration for his fitness for the job. HERBERT HOOVER'S candidacy was in effect a protest against the old régime, and the popular support which unquestionably was his throughout the country was a rally to that protest. We need waste no words of denunciation over what was done at Chicago, but we cannot be blind to the need, more insistent than before, of a new type of thinking in national affairs.

No group of engineers or technically trained men would be guilty of such a monstrous farce as was perpetrated at Chicago last week. They do not select an artist to design and build a bridge nor a dispensing druggist to operate a great chemical works; nor would they pick a second-class politician to direct the complex affairs of a great nation. Their training and experience naturally protest against the selection of anyone unfit for his duties.

It is indeed time that the voice of the engineer be heard in public affairs. We know that his methods and policies will not please the orthodox political leader, but we are quite cetain that the results of his labors will be to the advantage of the country. Unless there be something in political life which leads men to forsake the dictates of their best judgment, we believe that engineers would select men with something of the same care and particularity that they now apply to materials of contruction. The same powers of logic and analysis that they now bring to bear on the solution of a scientific problem would be applied in diplomacy and statesmanship; and their previous success in professional work would be a recommendation worth considering.

Somehow the longer we contemplate the Republican national convention, the prouder we are of the conference of engineers in Washington when the Federated American Engineering Societies was formed.

Congressional Acts of Omission

WHATEVER may be one's personal opinion and preference on the Treaty of Peace and the League of Nations, and the merits of the controversy between the President and the Senate, it is impossible to escape the conviction that commerce and industry have suffered because Congress was so embroiled in a political fight that it failed to give attention to the industrial needs of the nation. Legislation of the utmost importance was sidetracked while eloquent Senators paid their respects to members of opposing political parties, with the result that Congress adjourned *sine die* without enacting vital legislation on which a vast amount of time and energy had been spent. The so-called dye bill designed to foster and protect the domestic coal-tar industry was filibustered to death by Senator THOMAS, who apparently is a blind opponent of protection to American industry. It may be that the proponents of the bill were too anxious and too confident, and that their own testimony gave basis for the belief that a monstrous monopoly would be established. And we know how odious an industrial monopoly has been in recent years. It is further evident that the conflict of interest between the makers and users of dyes prevented harmonious support of a tariff program.

All other tariff bills relating to minerals, glass, porcelain, apparatus, etc., died without action.

The water-power bill was passed by both houses of Congress, and those who had worked so insistently for twelve years to secure legislation on this subject hoped that their labors would be rewarded. It was unfortunate, therefore, that the President, for whatever reason, failed to sign the bill before Congress adjourned. Possibly this was due to the fact that the Departments of War, Agriculture and the Interior were concerned with the bill and were unable to approve it for signature in due time. The Attorney-General is reported to have stated informally that the President has ten days following the adjournment of Congress in which to sign bills, but no official pronouncement has yet been made. Water-power development in the United States is therefore delayed for another year or two—a period during which we may expect high prices for coal and labor, and one in which the development of economical power will be most urgent.

The bill to establish the United States Fixed Nitrogen Corporation was, at the last moment, favorably reported to the Senate. This gives it the advantage of a position on the calendar, but the long delay which must ensue in its further consideration, during which time the Government nitrate plants must remain idle, is greatly to be regretted.

The bill to increase the force and salaries in the

Patent Office also died without action. This is greatly to be regretted, because salaries in the Patent Office are woefully inadequate and the service is suffering by the resignation of men who can no longer enjoy the luxury of working for the Government. We are less sympathetic, however, with the other patent bill, authorizing the Federal Trade Commission to accept and administer, for the benefit of the public, inventions, patents and patent rights. Such a bill passed the Senate March 22, and was on the House calendar for consideration. In modified form it was saddled as a rider onto the salaries bill. Whatever may be the merits of this proposal, they seem at first glance to be outweighed by obvious objections.

Practically the only act of Congress in which chemists can take any satisfaction was the passage of the Army reorganization bill, in which provision was made for the retention of the Chemical Warfare Service as a separate unit. This was accomplished after all hope seemed to be lost, and in spite of the unsympathetic attitude of the Secretary of War and the Chief of Staff. That Congress was able to see the light as presented by proponents of the measure is greatly to its credit.

The Relation of Botany to Chemistry

IN A late number of the *Journal* of the Society of Chemical Industry J. B. FARMER called attention to the rather neglected relations between economic botany and chemical industry. He urged a more intense consideration of the subject, and we second the motion.

In a popular article lately published in the *Saturday Evening Post* Dr. HERBERT C. HOOVER called attention to the fact that our leading economic requirement today is to make agriculture produce and thrive. The situation is that unless we grow our own food and clothing we must buy material for these needs abroad, and the obligation to do this will put us in the position in which England and Germany were before the war. We shall be competitive buyers of food and clothing in foreign countries and as one of the earth's industrial nations we shall need to maintain a great navy to keep the best markets open to us, we shall be in constant strife with our neighbors for advantage in this respect and the outlook for living on terms of amity with them will become cloudy. On the other hand, if we produce our own food and raiment, we can manufacture as much as we can find a market for and there will be nothing to hinder us from living in peace and good will toward all and from all. He emphasized, as the greatest hazard to this desired condition, the invasion of agriculture, which has been in process for some time, by industry. If industry draws labor away from the farms, the farms cannot produce.

There are also other sides to the relation of agriculture with industry, and one of these is the needed introduction of engineering into farming. Our land does not produce what it should produce, and if good results are to be obtained this must be at least doubled. It can be done, provided we go about it intelligently; but it will require competent engineers to turn the trick. An example of such development is shown by the great area of former swamp land in western New York which was reclaimed under the brilliant leadership of THEODORE ELY KNOWLTON, of Rochester, a well-known engineer. The results showed increased values, agricultural wealth and more particularly increased production that were materially greater than was anticipated. Given the same wages, most men prefer to work in industry in cities to working on farms in the country. Why is this? Men tend to huddle together rather than to disperse like molecules in a gas. If we apply BOYLE'S law we shall recognize that this decrease in volume is due to increased pressure from without, and it is easy to learn that this pressure is due to a desire for freedom during hours of leisure, to a wish for fixed hours, to a desire for gossip, and to see lights at night, and because women are even more urgent than men in this respect. All these things may be had in industrial farming, and industrial farming is a problem of engineering, in its lay-out. But industrial farming is impossible without better yields, and better yields demand research in botany and biological chemistry and in the physiology of plants. Given a large industrial establishment with enough produce to look out beforehand for markets and distribution, with contented workmen, with control laboratories and research constantly in process, and it can succeed where the single farmer with a hundred and sixty acres of diversified products will fail. It will require thought and education and intelligence and imagination and administrative ability; but what are engineers for if not to supply these very requirements? With botany and chemistry wedded to engineering, industrial farming and abundant yields will become possible. In our number of June 2 we published an article by Dr. MILTON WHITNEY that told clearly how, under proper control, the economical use of fertilizers may be improved. What is needed is the very quality of intelligence that industrial farming can and probably will call to its aid.

Another side to the co-ordination of botany with chemistry is in the furnishing of raw materials for chemical industries. These come only in part from mines. There is a report of certain hybrid trees similar to spruce that grow with great rapidity, maturing within less than half the time of ordinary wild spruce. The meaning of such an achievement to the paper industry is of immense importance—but we have yet to learn of a confirmation of the report or of any excitement in the paper industry over the possibility of such a botanical masterstroke.

The best quality of book and magazine papers may be made economically from bamboo, and bamboo grows in the United States on the mainland and in great abundance in its possessions, but we don't seem to be bothering much about the nature and varieties of the shrub, despite the paper famine.

Occasionally we learn of organic chemical products that heretofore have been synthesized only with the greatest difficulty and at high cost, which are available in large quantities in certain kinds of plants. We don't even know why these substances are found there and we are greatly surprised when we learn it. As soon as we do we repair straightway to the earth-and-sun product for our intermediate material, instead of beginning with benzene or naphthalene, working an interminable time, and then getting only restricted yields. If we knew more about plants we should know where to get many products that are now hard to obtain.

The soil offers us raw materials in perpetuity. Isn't it worth while to see what it has to offer and to look into its capacity to supply us with many things we need? Sometimes botanists bring great gifts. There was CHARLES DARWIN, for instance. He was a botanist.

Minerals Separation Forestalled In Contempt Proceedings

JUDGE BOURQUIN'S decision dismissing the contempt proceedings brought by Minerals Separation, Ltd., against the Butte & Superior Co. appears upon another page. The complainants charged that Butte & Superior was using less than 1 per cent of oil in violation of the Court's injunction.

This decision—in which the complainant, Minerals Separation, Ltd., is "remitted to some one of the familiar methods to secure determination upon the merits of these alleged infringements" and is told that it "cannot be permitted to transfer the controversy from merits to contempt"—is of general interest because it is a check upon the tendency which Minerals Separation, Ltd., has developed to assume proprietorship of all flotation, because of the *result*. This assumption is contrary to the Supreme Court's decision in the Butte & Superior case, in which the court distinctly states that Minerals Separation, Ltd., is entitled to protection on a *process* and not on a *result*.

The decision is of particular interest, coming, as it does, just as an exactly similar attempt is being made to have the Miami Copper Co. declared in contempt.

Elimination Examinations Suit the Mirror Minds

REPORTS from the colleges throughout the country indicate that during the past year students in unprecedented numbers took up the study of chemistry. Everywhere both laboratory facilities and teaching staffs were strained. To meet the situation some institutions immediately enlarged both laboratories and staffs, some gave examinations to eliminate the excess of students, some did both and some did nothing with the result that their educating effectiveness was considerably reduced. Of these four measures, only the first can be approved, the second should not be tolerated, the third may be excused with certain reservations, while the fourth should not be awarded the dignity even of consideration.

The passing of both rigid entrance qualifications and examinations should be required and no larger classes formed than can be efficiently taught. It is altogether a too common practice to allow an excess initial registration and then after a month or so flunking all but the number for whom apparatus can be provided, leaving a lot of men stranded at a critical time. Some institutions are reported to have made as high as 40 per cent reductions this year in chemical courses apparently without a thought of their true obligations.

The reason why the elimination of excess students by means of examination grades alone should not be approved will readily be seen from the following:

A few years ago the dean of a well-known university in looking over the grades found that the examination marks of four Chinese students were suspiciously alike. He immediately sent for their examination papers and upon comparing them found they were so nearly identical that three must be copies of an original. In order to find which ones were the rogues, the Chinese were told that their examination papers had been lost and it would be necessary for them to write them over again. Every precaution was taken to catch any signs of communication among them, but not a trace of cheating was observed. When the second examination had been finished the dean was astonished to find that he had not solved the question, for he had four more identical papers. The perplexity was eventually solved by finding that all four Chinese were honorable copiers, each having memorized the language of their texts.

From their complicated language the Chinese have received an exceptional amount of memory drill, which soon becomes a phenomenal quantity if further exercised in stowing away an American college education. Such a development of memory produces a mirror mind, which reflects all that enters it with ease. In some professions, such as acting, the mirror mind is at a premium, but in the practice of the sciences it may be quite mediocre. Yet the grades received from most any examination possible to devise are to an important extent a function of mirror mindedness. Therefore they should not be a prime factor in determining whether or not a student can profitably use his time studying a science, chemistry at any rate.

In reporting the final grades of Chemistry Y to the professor in charge, a young assistant felt very enthusiastic because every student had received a mark above that required for passing. He was very much upset when his superior not only did not reciprocate, but began scanning the list with a view of getting at least a man or two. Muttering to himself, "This will never do. What will the dean think of this course if I pass everybody?" the professor finally picked out SMITH, who had only a snug margin over the flunking line. Knowing SMITH'S case well, the assistant took up his defense, stating that while SMITH was not as brilliant in expressing himself in an examination as the others, he had worked harder than most of the men in the course and merited passing. In after years SMITH was numbered within the few of that class who made successful use of their chemical training.

It is obvious that if SMITH'S class had been too large to suit stinted college facilities, he would have been one of the first to fall before the elimination examination. Some other standard of sizing up students is needed, and if any are to be eliminated from continuing the chemical courses, it should be the ones who are not putting all their efforts into their work and just get by with the aid of a mirror mind. The young stuttering Demostheneses should not be sacrificed because they lack a nimble tongue at examination time.

Cleaning Up Mexico—With Soap

STATISTICS are proverbially dry and uninteresting, and even the curious would scarcely look for anything startling in figures showing domestic exports of soap from the United States. But we submit that there is food for thought in the fact that in April of this year of grace we sent 2,352,313 pounds of soap to Mexico. This was one-fourth of our total exports of soap. Visions of the great unwashed should fade before such evidence of cleanliness, for it may safely be assumed that the commodity is used in processes of ablution. And if it be true that cleanliness holds among the virtues the exalted position usually ascribed to it, our southern neighbors are perhaps more godly than we thought. Here are possibilities, maybe, undreamed of by statesmen, soldiers and missionaries. What a simple process of regeneration and conversion—moral and spiritual! How delightful the transformation through unction applied to body and soul; superior to bullets and less distressing than gas. The chemist may yet be called upon to clean up Mexico.

Western Chemical & Metallurgical Field

Liberty Potash Co. in Receiver's Hands

The Liberty Potash Co., which was organized by Salt Lake City interests for the extraction of potash from leucite in Wyoming, is in the hands of the Bankers Trust Co. as receiver. Efforts are now being made to re-finance the company with the intention of putting the plant in operation again. It is reported that about $800,000 was raised originally for the construction of the plant at Green River, Wyo., and that subsequently an indebtedness of about $300,000 was contracted in its operation, making a total of $1,100,000 represented in the venture.

The lack of adequate technical direction in the design and operation of the plant is assigned as one of the reasons for the failure of the company. Potash in the form of chloride equivalent to 35 per cent K_2O was produced to the extent of about twenty-one carloads, and proved to be an excellent material for fertilizer, and it is still believed that the process can be operated with sufficient skill and economy to make this product at a profit under present market conditions. In brief the process consists in volatilizing KCl by calcining leucite with lime rock and sodium chloride in the ratio 60:30:10, and catching the volatilized chloride in bags.

Photographic Chemicals Being Produced on the Pacific Coast

The production of the so-called "modern" photographic developers in this country is a recent achievement and marks a step in the advance toward our chemical independence. Previous to 1915, for instance, all of the "metol" used by American photographers was imported, being produced almost entirely in Germany, a relatively small portion being made in France. When the importation of this largely used developer was cut off, "serchol," which was manufactured in England, was offered and used extensively as a substitute.

It seems to be the consensus of opinion that "metol" of the highest purity has advantages not possessed by other developers, and the production of this chemical was undertaken by many chemists and chemical manufacturers during the last four years, but until recently without great success. A very satisfactory grade of metol is now being made by the American Chemical Co., of San Francisco, and is largely used by the motion-picture studios near Los Angeles as well as being supplied to the general trade. The process by which it is made was developed by W. J. Van Sicklen, and he has also been successful in the production of hydroquinone and other photographic chemicals, together with a few allied pharmaceuticals.

Until recently practically all of the heavier photographic chemicals used in the West have been made in the East. The Arthur R. Maas Chemical Co., of Los Angeles, has developed a process for the manufacture of and is now producing considerable quantities of "hypo" and sodium sulphite.

The "metol" and "hypo" are being produced from raw materials obtained locally or else imported directly from the Orient to Pacific Coast ports. This indicates that the chemical industry in this section of the country has advanced to an extent sufficient to supply materials needed in the manufacture of the more refined chemical products.

Fuel Oil Becoming Scarce and Expensive

Failure of existing and prospective oil fields to maintain equality of production to the consumption of petroleum products has been predicted by reliable authorities. The truth of this is already becoming apparent and the situation is acute in certain parts of the country. In March of this year the Standard Oil Co. (California) increased the price of fuel oil 25c. per bbl. and of gasoline 2c. per gal., at the same time paying an additional 25c. per bbl. for crude oil at the wells. In announcing this advance the company stated that an increase in prices was the only known and tried means at its disposal that would bring about an increased production of crude oil, prevent the shipment of fuel oil and gasoline to competitive markets and at the same time restrain demand. In January, 1920, the output of California's refineries amounted to about one-tenth of the gasoline and one-quarter of the fuel-oil production of the United States. It is but a question of time until conditions such as now exist in California will be reflected throughout the country and ultimately result in becoming a question of national importance, since there is now lacking an adequate means of effectively combating the situation.

Power derived from fuel is becoming increasingly expensive and the consumer of power so obtained must face an uncertainty in the supply, this being particularly true of that from fuel oil. Recent experiences, the result of strikes affecting transportation and the production of fuels, have brought this forcibly to attention. In establishing new industries, the source of power and the effect of increased consumption on the future costs are factors which must be given consideration; more particularly will increased power costs adversely affect electrochemical industries.

The Resources of Colorado

In a recent address before the Denver Commercial Club, Charles C. Gates showed that the state possesses 1,000,000 undeveloped hydro-electric hp. according to the U. S. Geological Survey, 385,000,000,000 tons of unmined coal and vast oil shale deposits which have been shown to hold seventeen times as much oil as taken out in the wells of the United States since 1857.

With charts prepared by the Denver Gas & Electric Co., he demonstrated that Denver's power is supplied at cheaper cost than that prevailing in the Atlantic States, Eastern Central States, and Western cities except Los Angeles, which has the lowest power costs in the country. Aside from the production of the metals, Colorado offers many possibilities to the chemically-controlled industry.

Copper and Magnetite in Copper Smelter Slags—I

Chemical and Microscopic Examination of a Series of Representative Slags, Showing How Copper Losses Occur, the Relation of Magnetite to Copper Loss, the Behavior of Converter Slags in Reverberatory Furnaces and Suggestions for Reducing Copper Slag Losses

By CHARLES G. MAIER and G. D. VAN ARSDALE

TODAY'S urgent necessity for the maximum economy of operation of all basic industries should renew the interest of metallurgists in smelter losses. Maximum production being no longer an immediate *sine qua non*, a critical examination of even those losses which ordinarily are deemed at a minimum is entirely justified.

In considering the problem of metal loss in copper smelter slags, two aspects are pre-eminent: How far is satisfaction with a conventional average 0.3 or 0.4 per cent copper loss in reverberatory or blast-furnace slags justifiable? and, What should be done with secondaries? In attempting an answer to these or similar questions, one may search technical files in vain for such fundamental information as the actual condition in which copper exists in slags, or even as to just what happens when converter slags are poured into reverberatories.

Such information as is available is usually the result of personal experience in the operation of furnaces. Thus one person may postulate that, because he has had trouble with unsettled prills of matte in slag, such constitute the serious source of loss, if not its totality, while another who has had matte-clean slags suspects only the presence of oxides in the silicate portion of the melt, and still others suspect, but do not explain, some relationship between magnetite in slags and copper loss. All are correct in degree, but a comprehensive theory to account for empirical facts, and based on close examination of the actual materials themselves, is lacking and would seem to be highly desired.

In a previous article[1] the authors have attempted to show that while chemical methods of attack, when used alone, are inadequate for the development of any comprehensive theory, a combination of chemical and microscopic methods seems capable of furnishing much new and interesting information. After a brief discussion of previously published material, the article mentioned points out the manner in which the copper constituents and the magnetite in reverberatory, blast-furnace and converter slags may be classified, and presents experimental evidence for distinguishing the various forms of inclusions, etc.

While this previous work was entirely confined to samples representative of the practice at that time in various Phelps Dodge Corporation branches, opportunity has since been had to extend the examination to various other slags produced at copper matte-smelting works, and moreover work has been done on samples from reverberatories taken during the admixture of converter slag. This latter work in particular throws much light on previously obscure relationships between copper loss and magnetite or ferric iron, and has led to the attainment of a mental picture of various phases of matte smelting which should be of general interest.

[1] Eng. and Min. J., May 10, 1919, vol. 107, p. 815; abstracted in Chem. & Met. Eng., vol. 21, pp. 46 and 61.

Résumé of Previous Work by the Authors

Inasmuch as the discussion of the work described in the present article is very closely related to previous results, the following brief summary of the latter is given.

It was found that in the reverberatory and blast-furnace slags examined there was present but one microscopically visible form of copper—namely, a matte *residue*. Matte on solidification seems to be primarily a two-constituent material, containing an iron sulphide constituent saturated with copper sulphide, and a copper sulphide constituent saturated with iron sulphide or metallic copper. The latter phase is equivalent to white metal and it is this part of the original matte which is visibly distinguishable as pellet-like inclusions in the slag. Quantitative chemical methods, devised to determine the amount of these pellets, accounted for only a part of the total copper, the difference being copper dissolved in the silicate portion of the slag. The amount dissolved was found to be approximately constant and between 0.15 and 0.20 per cent. Further chemical and microscopic evidence indicated the dissolved content to be present as sulphide. The facts that the visible pellets of copper sulphide were only rarely matte and usually white metal, the disappearance of the iron sulphide constituent being accompanied by the presence of gas bubbles, tending to keep the pellet afloat, were taken to indicate chemical reactivity with the formation of sulphur dioxide. The reaction was concluded to involve the oxidation of iron sulphide, or possibly copper sulphide by ferric iron.

In converter slag a larger portion of the copper content was found to be the pellet form of white metal, although the dissolved content was in these slags varied, averaging from 0.1 to 0.5 per cent copper.

Of great importance in relation to our present work was the classification of slags according to the magnetite crystals occurring therein, as follows:

1. Slags without visible magnetite crystals typical of blast-furnace or extremely rapidly chilled reverberatory slags.
2. Slags showing magnetite crystals formed during solidification, typical of usual reverberatory slags.
3. Slags with well-formed, clean-cut and large magnetite crystals, formed during the molten condition, typical of converter slags.

Effect of Adding Converter Slags to Reverberatories

In March and April, 1919, a series of reverberatory slag samples was taken at the Copper Queen smelter, representing the condition of slag at time intervals, before and after the addition of molten converter slag. The microscopic and chemical examination of these samples in the light of previous work on the classifica-

tion of copper losses and magnetite crystal forms has led to some interesting results.

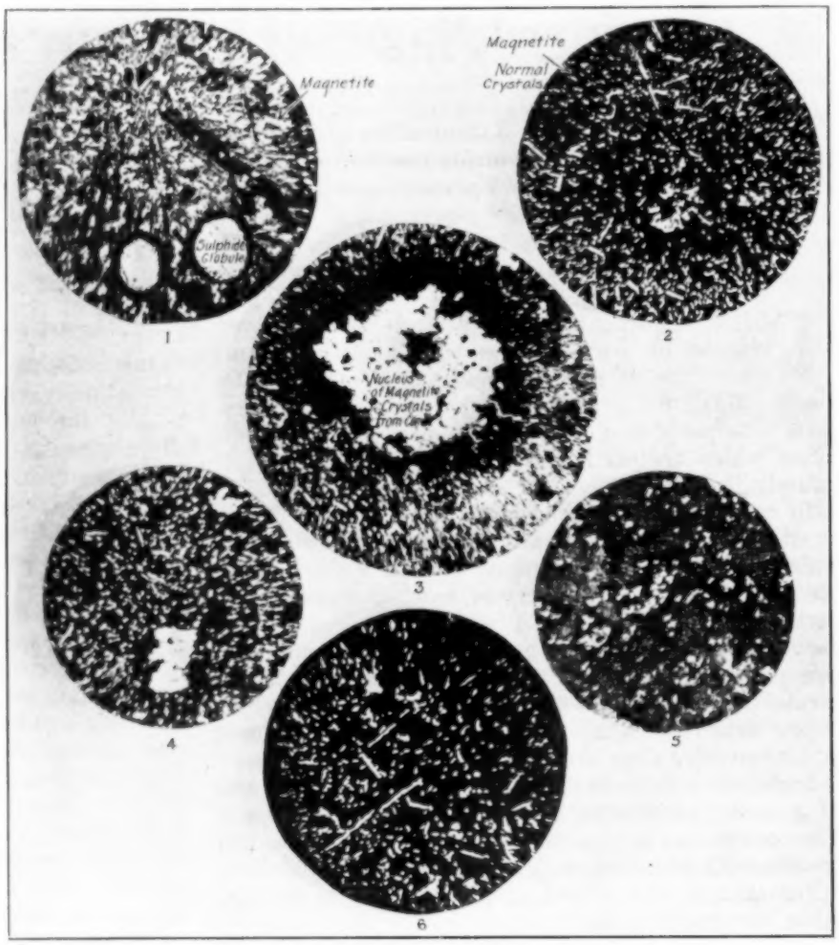
A cursory microscopic examination of these samples, which were taken at the time of converter-slag pour, and at lapses of ten, twenty, thirty and forty minutes, shows no unusual condition as far as copper content is concerned, except for the presence of some metallic inclusions (which will be discussed below). Consequently the chemical method for distinguishing between the total dissolved and pellet copper (silver nitrate method described in previous article) was considered a satisfactory criterion for the chemical determination of the effect of the addition of converter slag to reverberatories. Table I shows the results obtained.

The effect of the admixture on the copper content of the *mixed* slag is clearly indicated by the first row of figures, showing that the total copper content increases unmistakably. The increase is completely due, however, to an increase in the sulphide copper globule content. The third row of figures, giving the dissolved copper, shows practical constancy for the entire period of the test and even samples taken a month later, shown in the second part of the table, have an average dissolved copper content extremely close to the original.

If one assumes 0.06 per cent copper, as shown in the table, to be the normal globule content before the addition of converter slag, the last row shows an excess amount of globules, due to the addition, and of about the same order of magnitude as the normal, and even though the total amount of copper represented be small, the results seem to warrant the conclusion that the addition of converter slag was the cause of a definite increase in suspension not to be accounted for by the small percentage of secondary slag added.

There is no *a priori* reason discernible why the dissolved copper content of reverberatory slags should be changed by the addition of moderate amounts of converter slag, which affect only to small degree the composition and temperature of the melt. Theory and observation are in accord here. For the suspended globules, however, if previous theories of the reaction of sulphides of iron with ferric iron are correct, there should be found in the iron content of the slag the explanation of the increase of suspended copper noted in Table I.

The flotation effect due to the reaction of ferric iron with sulphides to form sulphur dioxide gas should be related to the ferric iron content of the slag. Microscopically it is possible that only a part of the ferric iron is visible as magnetite. Moreover, the magnetite, as revealed, is so variable as to render quantitative results from microscopic examination impractical, so that a chemical method of correlation was sought. The method finally chosen for the chemical determination of ferric iron in these slags was that of disintegration with hydrofluoric acid in the presence of an atmosphere of carbon dioxide. There are objections to this method, but details of procedure and the justification of the method for the present purpose will be found in the appendix.



FIGS. 1 TO 6. MICROSECTIONS OF SLAGS FROM COPPER QUEEN SMELTER
Fig. 1. Converter slag. Fig. 2. Reverberatory slag before addition. Fig. 3. Reverberatory slag, 10 min. later. Fig. 4. Reverberatory slag, 20 min. later. Fig. 5. Reverberatory slag, 30 min. later. Fig. 6. Reverberatory slag, 40 min. later. All microphotographs originally at 75 ×, reproduced at 40 ×. HF etching.

The results obtained are of first interest, as will be evident from the examination of Table II. As expected, there is a definite increase in the ferric iron content of the reverberatory slag after the addition of converter. Whether or not the total ferric iron content should be considered as magnetite is scarcely pertinent for the present discussion, for since magnetite is re-

TABLE I. COPPER IN REVERBERATORY SLAGS BEFORE AND AFTER ADDING CONVERTER

Sample and Time After Pour	Part I — Original Set of Samples						Part II — Same Furnace 1 Month Later		
	Reverb. at Pour 0	After Reverb. 10 Min.	After Reverb. 20 Min.	After Reverb. 30 Min.	After Reverb. 40 Min.	Convtr. at Pour 0	After Reverb. 25 Min.	After Reverb. 35 Min.	After Reverb. 45 Min.
Total Cu	0.28	0.36	0.31	0.33	0.32	3.77	0.35	0.27	0.32
Suspended Cu	0.06	0.13	0.09	0.10	0.11	3.27	0.11	0.07	0.08
Dissolved Cu	0.22	0.23	0.22	0.23	0.21	0.50	0.24	0.20	0.24
		Average 0.223					Average 0.23		
Abnormal* globule content	0.06 (normal)	0.07	0.03	0.04	0.05	....	0.05	0.01	0.02

*Suspended Cu globules after addition, minus normal suspended content.

TABLE II. IRON AND SUSPENDED COPPER IN REVERBERATORY SLAG BEFORE AND AFTER ADDITION OF CONVERTER SLAG

Sample Taken	Part I Original Test: Reverb. Slag at Pouring of Convtr.	Part I: After 10 Min. Pour	Part I: After 20 Min. Pour	Part I: After 30 Min. Pour	Part I: After 40 Min. Pour	Part I: Convtr. Slag at Pour	Part II Same Furnace One Month Later: After 25 Min. Pour
Total iron	29.26	29.64	29.69	30.26	27.78	.....	34.26
Ferrous iron	27.79	27.28	27.13	28.09	25.85	.....	31.89
Ferric iron	1.47	2.36	2.56	2.17	1.93	11.4*	2.37
Magnetite†	3.0	4.9	5.3	4.5	4.0	23.7*	4.9
Copper as suspended globules	0.06	0.13	0.09	0.10	0.11	3.27	0.11
Ratio Cu as susp. glob. / Ferric iron × 100	4.1	5.5	3.5	4.6	5.7	.....	4.6
		Average 4.8± 0.8 A.D.‡					
		Total average 4.7± 0.7 A.D.‡					

*From photograph, not a chemical determination.
†Based on assumption of complete crystallization of ferric iron as such, probably unwarranted, but given for comparison with photograph.
‡A.D.=average deviation from mean.

active with sulphides, as proved by the appended photomicrographs, the total ferric iron is the real deciding factor in the suspension of sulphide globules.

Qualitatively there can be no doubt that an increase of ferric iron in slag is closely related to increased suspension, the third and fifth rows of figures in Table II indicating conclusively the coincidence of an increase of suspension with an increase of ferric iron.

That this relationship is quantitative as far as the accuracy of chemical determination enables one to judge is indicated by the figures of the last row. If the suspension of sulphide globules were strictly proportional to the ferric iron content

$$\text{Suspended Cu} \propto \text{Fe}'''$$

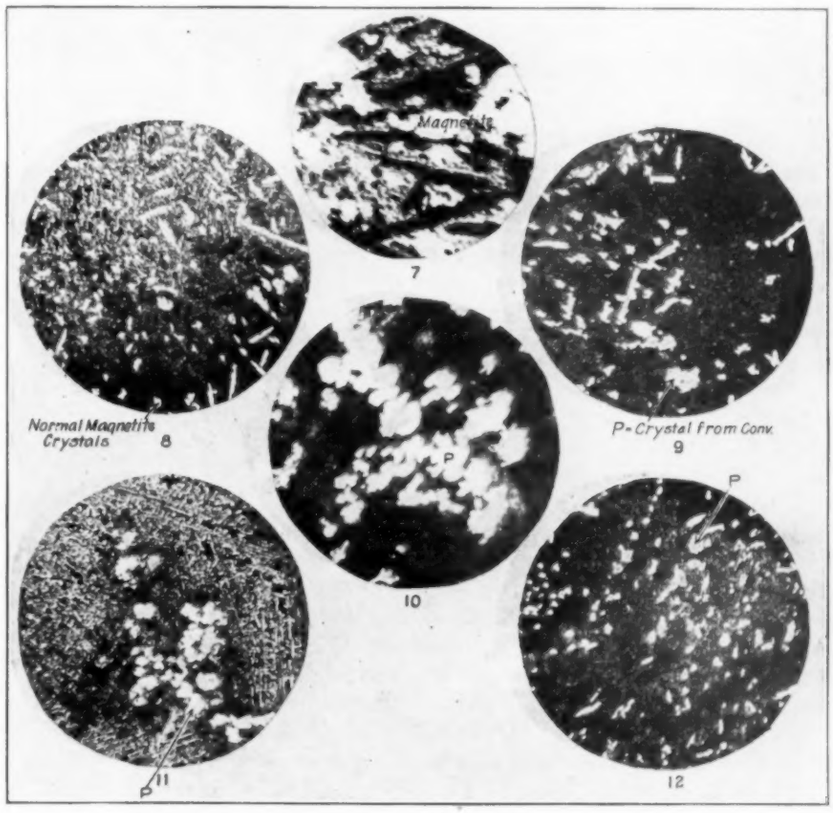
then

$$\frac{\text{Suspended Cu}}{\text{Fe}'''} = K$$

where K is a constant numerical ratio. This figure is the one given in the last row, and while these numbers do not show absolute constancy, the variation observed, indicated by the average deviation from the mean value, is approximately 15 per cent. Since the figures involve the determination of an amount of copper of the order of magnitude of 0.1 per cent, this deviation corresponds to an original error of 0.015 per cent copper, which is just about the limit of accuracy of the determination made, and consequently one is warranted in concluding that numerical proportionality exists between suspended copper and ferric iron in these tests.

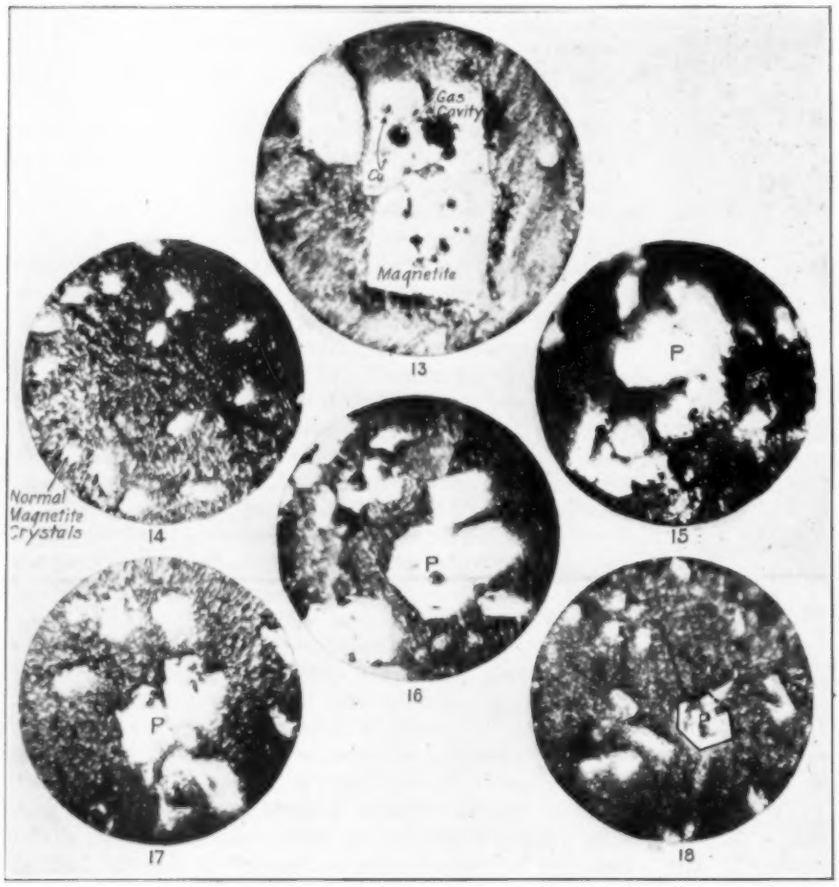
From the microscopic point of view the above conclusions regarding the relationship of sulphide inclusions in slags to ferric iron is confirmed by the behavior with magnetite which may be actually observed upon examination of polished sections. Figs. 1 to 6 show pictures of the series of samples taken from 0 to 40 minutes after the addition of converter slag, which were taken at low magnification, and which serve more as an indication of the distribution of magnetite than as a true basis of comparison of its amount. The distribution is not sufficiently uniform to serve as a quantitative guide without the use of an excessive number of observations. There are some points, however, of considerable interest. Compare, for example, the normal size of magnetite crystals (converter slag) in Fig. 1 with the normal size in Fig. 2 (reverberatory slag without the addition of converter), and it is apparent that the normal magnetite in reverberatory slag due to crystallization on solidification is considerably smaller in size than that occurring in the normal converter slag where crystallization takes place in a liquid medium. The fact that large crystals of magnetite, exactly similar in appearance to those which previous work has shown to exist in the fluid condition of converter slag, are found in the reverberatory after admixture can be taken to indicate that these particular crystals are the identical ones which existed in the liquid converter slag upon addition to the reverberatory. Furthermore, when after ten minutes' time from the addition large nuclei of highly magnetitiferous slag are seen in the reverberatory sample (Fig. 3), it is an obvious step to conclude that this condition represents the primary step in the assimilation of the converter slag by the reverberatory.

These agglomerates of magnetite crystals disappear with time, confirming the idea of some mode of disintegration of the magnetite other than silicate fluxing,



FIGS. 7 TO 12. MICROSECTIONS OF SLAGS FROM COPPER QUEEN SMELTER AT HIGHER MAGNIFICATIONS

Fig. 7. Converter slag. Fig. 8. Reverberatory slag before addition. Fig. 9. Reverberatory slag, 10 min. later. Fig. 10. Reverberatory slag, 20 min. later. Fig. 11. Reverberatory slag, 30 min. later. Fig. 12. Reverberatory slag, 40 min. later. All microphotographs originally at 150 ×, reproduced at 80 ×. HF etching. "P" marks magnetite crystals from converter slag.



FIGS. 13 TO 18. MICROSECTIONS OF SLAGS FROM COPPER QUEEN SMELTER AT VERY HIGH MAGNIFICATION

Fig. 13. Converter slag. Fig. 14. Reverberatory slag before addition. Fig. 15. Reverberatory slag, 10 min. later. Fig. 16. Reverberatory slag, 20 min. later. Fig. 17. Reverberatory slag, 30 min. later. Fig. 18. Reverberatory slag, 40 min. later. All microphotographs originally at 1000 ×, reproduced at 550 ×. HF etching. "P" marks magnetite crystals from converter slag.

as this would require gradual diminution in size of individual crystals. There is evidence, discussed below, that there is considerable tendency for magnetite crystals, when present in fused slag, to settle rather rapidly to the bottom, and the fact of these nuclei remaining suspended indicates the manner in which converter slag is taken up by the reverberatory. There would seem to be no reason for the coherence of these magnetite crystals except through the medium of some surface tension effect in the fused slag. It is a well-known fact that any magnetic phenomena which these crystals might show disappear at a relatively low temperature. The action taking place is, then, first of all, upon addition of fused converter slag containing magnetite crystals to the fused reverberatory slag, the silicate portion of the converter slag is dissolved away into the silicates of the reverberatory, leaving magnetite crystals and numerous sulphide copper globules which were originally present to the extent of several per cent. It will be shown later that copper sulphide in the molten state wets the surface of magnetite crystals, and consequently each original sulphide globule attaches to itself any magnetite crystals with which it may come in contact. There is exact analogy here with the manner in which sulphide minerals attach themselves to oil drops in an aqueous pulp, magnetite taking the place of mineral and fused sulphides that of the oil. According to previous work, sulphur dioxide should be the result of chemical reactions involved in such contact, and accordingly there is to be seen a central gas cavity in Fig. 3. This gas has buoyed up the nucleus and the reactivity is obviously the reason for its continuous suspension in the liquid slag.

Figs. 7 to 12, of specimens similar to Figs. 1 to 6, but at twice the magnification, show somewhat more clearly the difference in the size of the magnetite crys-

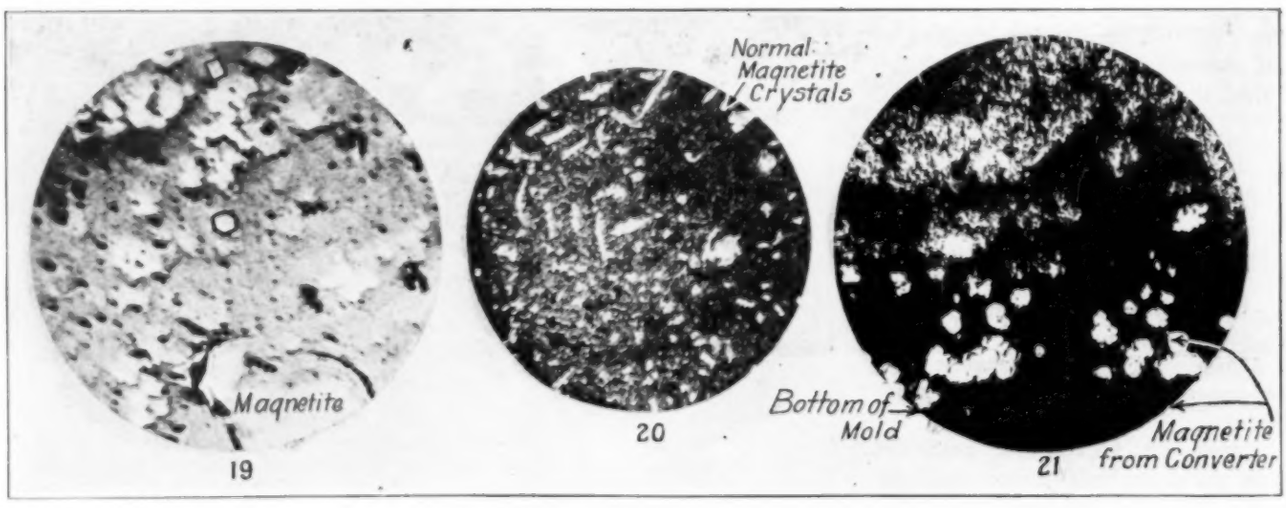
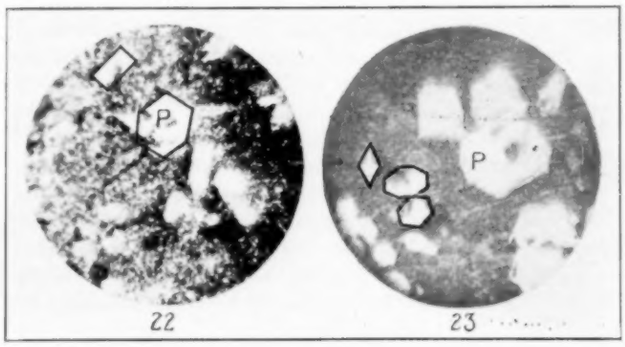


FIG. 19
Outlined crystals show average size of magnetite in converter slag. 150 ×, reproduced at 115 ×. Unetched.

FIG. 20
Reverberatory slag, 10 min. after addition. Center of slag sample showing no large crystals of magnetite. 150 ×, reproduced at 115 ×. HF etching.

FIG. 21
Same slag sample as Fig. 20 but at bottom of mold. Showing large magnetite crystals settled to bottom. 150 ×, reproduced at 115 ×. HF etching.



FIGS. 22 AND 23. SURFACE DISINTEGRATION OF MAGNETITE CRYSTALS

Fig. 22. Reverberatory slag, 40 min. after addition. Fig. 23. Reverberatory slag, 20 min. after additions. Both 1000 ×, reproduced at 525 ×. HF etching. P and outlined crystals are magnetite from converter slag.

tals from the two sources originating either in the converter slag or in the normal crystallization of the reverberatory slag on cooling. Again, the crystals in Fig. 7 (converter slag) as compared to those in the unmixed reverberatory (Fig. 8) are seen to be several times as large. In Fig. 9, ten minutes after admixture, not having accidentally struck a position on the slag showing a nucleus, there are visible only occasional large magnetite crystals which had their origin in the matter of considerable significance and is plainly shown in Figs. 13 to 18. These pictures were taken at a very high magnification (originally 1,000 diameters) and emphasize anew the marked difference in size and structure between the crytals from the two sources. Their especial interest, however, lies in the fact that not only do they show the above-mentioned inclusions in large magnetite crystals, but also show crystal skeletons of originally large crystals whose sides or interiors have been disintegrated because of chemical fluxing action (effect of sulphides!).

Fig. 13 shows a very large and well formed magnetite crystal present in converter slag, and enables us to distinguish two types of inclusion. The large dark spots are gas cavities or at least unfilled holes in the magnetite crystal and their perfectly spherical form would seem to indicate the action of chemical disintegration after the formation of a large perfect crystal had taken place rather than an original cavity due to imperfect crystallization.

The lighter poorly defined inclusions are metallic copper, recognizable as such by the color on visual observation and by the deposition of silver crystals on etching with dilute silver nitrate solution. This phenomenon of copper inclusion may account for the variation on dissolved copper content observed with converter slags when tested by the silver nitrate method, inasmuch as

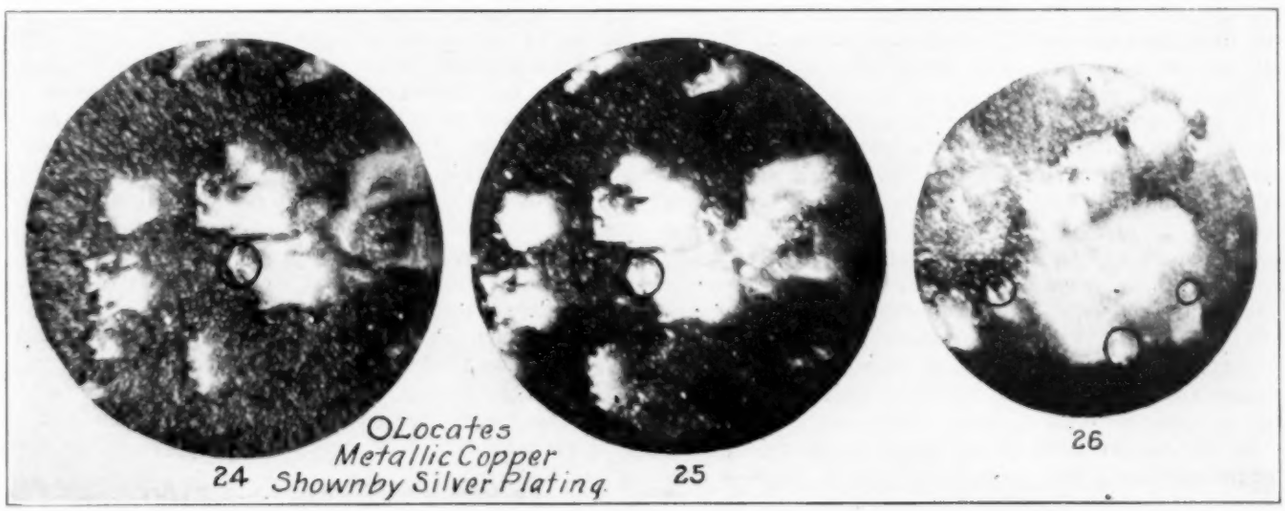


FIG. 24

Reverberatory slag 30 min. after addition, HF etching. Many copper inclusions visible to eye, but not distinguishable in photograph. 1000 ×, reproduced at 750 ×. HF etching.

FIG. 25

Same specimen as Fig. 24 after $AgNO_3$ etching. Silvery spots locate copper inclusions. 1000 ×, reproduced at 750 ×. Double etching.

FIG. 26

Reverberatory slag 10 min. after addition. Same appearances as in Fig. 25. 1000 ×, reproduced at 750 ×. Double etching.

converter. These have been designated by the letter *P*. A necessary consequence of the reactivity between magnetite and sulphide inclusions would be the disintegration of the former crystals, and in Figs. 10 and 11 there is apparent a beginning of such action, even though the total outline has not appreciably changed. It is interesting to note, in confirmation of the previous statements, that in Fig. 11 the difference in structure in the silicate phase is visible in the vicinity of the nucleus. As usual, after forty minutes the greater part of the large magnetite crystals have disappeared, and there remains only the normal magnetite crystallization characteristic of unmixed reverberatory slag.

Copper Inclusions in Magnetite

The inclusion of metallic copper in magnetite crystals, heretofore never observed, so far as is known, is a

these inclusions are extremely minute and would certainly not be freed by grinding through 100-mesh screens.

The magnetite crystals of Fig. 14, unmixed reverberatory slag, are much smaller and seem not to contain inclusions. If inclusions do occur they must be of little relative significance as far as the copper content of the slag is concerned, inasmuch as no such inclusions are apparent at 1,000 diameters magnification.

Figs. 15 and 16, photographs taken on samples ten and twenty minutes after admixture, show, in contrast to the above, characteristically large magnetite crystals and, of especial interest, also show metallic inclusions. Since the amount of copper in the original converter slag represented by such inclusions in crystals can certainly not be greater than the total dissolved copper—that is to say, approximately 0.5 per cent—it must be

FIGS. 27 AND 28. DIRECT REACTIVITY OF SULPHIDE UPON MAGNETITE
Fig. 27. Reverberatory slag, 20 min. after addition. Fig. 28. Converter slag. Both 1000 ×, reproduced at 500 ×. HF etching.

true that in mixed slags containing 10 per cent or less of converter slag, the effect of such inclusions does not involve significant quantities. At least some portion of metallic inclusions would be shown up as globule content by the silver nitrate method. It is important that these inclusions not observed in normal reverberatory slag are apparently characteristic of the converter and their presence in this mixed slag seems to furnish still further conviction as to the source of the crystals in which they occur.

Of even greater importance in regard to a possible rational explanation of the relationship between copper and magnetite in these slags is the second significant fact that magnetite crystals in the later pictures (see also Figs. 22 and 23) and particularly in Fig. 18 show ragged edges and fragments of originally rather large magnetite inclusions. Inasmuch as such fragmentary crystals are not usual in the converter slag itself where the predominant sulphide constituent is high grade, characteristic of white metal, it seems warrantable to assume that the corrosive action is chiefly due to the iron sulphide portions of these reverberatory slags. This is further confirmation of our previous theory concerning the primary disappearance of the iron sulphide constituent in suspended globules.

Gravitational Settling

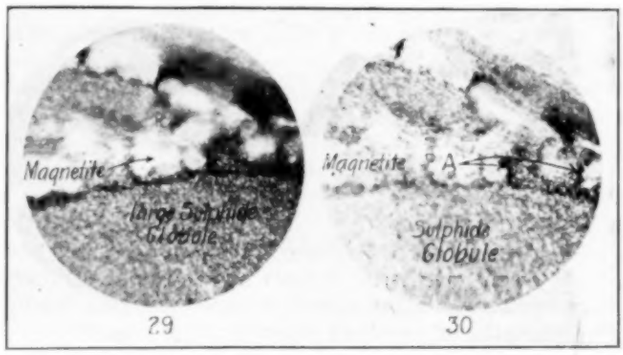
The separation of magnetite from fused slag by gravitational settling is a matter of considerable importance with respect to previous conclusions. It is true that as microscopically apparent on the usual specimen the number of large magnetite crystals characteristic of the converter is less than might be expected from the percentage admixture, but Figs. 19 to 21 show the explanation for this fact and furnish contributory evidence toward the theoretical relationships of sulphur elimination during and after matte smelting. Fig. 19 of converter slag has had two crystals outlined in ink to indicate the average size. Fig. 20, taken near the center of the mold as cast for sampling, shows only minute crystals characteristic of those normally found on solidification and lying in straight rows which indicate definitely their formation during this period. The last picture, Fig. 21, taken near the bottom of the mold, as indicated by the curved line in the margin, shows the number of magnetite crystals of the same size as those in the top section of converter slag. These crystals have settled to the bottom of the mold previous to the act of solidification.

Having shown in previous work the possibility of the reactivity of magnetite and sulphides, the mechanism for the disappearance of the larger magnetite crystals present because of the addition of converter slag can be easily imagined. Any crystal growing to considerable size during some molten condition, because of local oxidizing conditions in the melt, or when added as a large originally well-formed crystal through the medium of converter slag, becomes of a size to insure practically unhindered settling (compare Stokes' law, velocity varies as the square of the radius), rapidly comes in contact with the matte at the bottom of the melt and since it is wet by this phase is subject to rapid disintegration, quite in conformity to the action observed in many micrographs.

The reaction producing metallic copper by contact between magnetite and sulphides may be classified as to whether these sulphides be dissolved or present as suspended inclusions in the slag. In substantiation of the theory to be developed later regarding the correlation of magnetite and copper loss, it is desirable to show that the disintegration of the magnetite crystals is primarily due to reaction with sulphides rather than silicate fluxing. Figs. 24 to 26 show photographs taken to illustrate this point. Owing to the limitations of monochromatic reproduction the points of interest have been emphasized by artificial means. The first picture (Fig. 24) contains a typical group of corroded magnetite crystals. On the original, metallic copper inclusions were easily recognizable, located about the corroded crystal in such a manner as to leave no doubt that they were reaction products. In the absence of excess iron sulphide, the copper sulphide has continued to react with the magnetite, and since no pellets are visible it is probable that this copper sulphide was in the dissolved form.

Fig. 25 is from a photograph taken after treatment of the polished slide shown in Fig. 24, by an etching solution of silver nitrate, thus showing up copper inclusions by means of the bright spots of silver formed thereon.

While Figs. 24 to 26 were taken to show the reaction



FIGS. 29 AND 30. SURFACE TENSION EFFECTS IN SLAG
Fig. 29. Converter slag photographed under yellow monochromatic light. Fig. 30. Converter slag photographed under blue monochromatic light, showing copper in black spots. Both 1000 ×, reproduced at 500 ×. HF etching.

of dissolved copper sulphide with magnetite, the direct reactivity with globules of sulphide is a matter of some importance and is well illustrated by Figs. 27 and 28. Fig. 27 is a particularly good illustration of the reaction. The chief point of interest is the central magnetite crystal with the treelike growth in it. The small semicircular globule at the bottom of the large central magnetite crystal is the remains of a sulphide pellet, and the treelike growth is the path of the lines of penetration of the reaction. The minute globules at the end of the growth are appropriately enough the fruit of the reaction—that is to say, metallic copper.

Fig. 28 shows a much larger sulphide inclusion and the manner in which upon contact with magnetite the sulphide phase pours out of its spherical form to engulf and disintegrate the crystal. The ink lines indicate the extent of the engulfing action and serve to separate the silicate portion of the slag from the sulphide globule and its burden of attached reacting magnetite.

The matter of surface tension relationships between magnetite crystals and sulphide pellets has been mentioned above and Figs. 29 and 30 show photographs taken with the purpose of exhibiting this action. Metallic copper resulting therefrom is also apparent. The photographs have been made more clear by ink lines showing the outline of the constituents as well as by the use of color screens for contrast purposes in photography.

If magnetite were not wet by sulphide globules the reaction which is the source of the flotation of copper-bearing pellets could not take place so readily, and consequently it seems not impossible that some suitable addition agent might be found which when added to the fused slag would alter the surface tension effects in a manner similar to certain flotation poisons which have been noted by various observers in aqueous flotation pulps. If such agents could be found to prevent the wetting of the magnetite, there is no doubt that a considerable portion of the sulphide globule copper loss might be eliminated, since the elimination of the gas due to reaction would permit much improved settling.

(*Part II will be published in a subsequent issue.*)

Papers on Enameling Before the Chicago Section, American Ceramic Society

The Chicago Section of the American Ceramic Society met at a dinner at the City Club, Chicago, on Friday evening, May 21. In addition to the business program two papers were presented in connection with the enameling industry, the first of which, by L. H. Menne, was entitled "Enameling of Cast Iron."

Enameling of Cast Iron

The first thing to consider in the enameling of a cast-iron piece is its shape. This must be uniform and free from heavy spots and sharp edges. The metal must be a soft open-grain iron with a 2½ to 3 per cent silicon content and about 0.5 per cent manganese. Sulphur must be low.

Care must be taken in molding that the sand is neither too fine nor too coarse in order to obtain an open-grain surface. No facing must be used on the mold. In pouring the iron the metal must not be too hot, as then a film of scale and sand on the cold casting will make it impossible to produce a smooth enameled surface. It is better to cool the metal slowly in the mold in order to give an annealing effect and to prevent cracking of the casting during enameling.

Castings should not be milled before enameling, as this usually produces a too close-grained surface for best results. When necessary to do any finishing the castings must be pickled and sand blasted afterward. The enameling operation should be undertaken shortly after the sand blasting, but if castings have been stored a considerable time all traces of rust must be carefully removed.

Enameling is usually done in a gas-fired open-muffle furnace, the sides of the furnace being high enough to protect the ware from direct flame. The temperature should be from 1,500 to 1,600 deg. F. The slush coat is usually prepared in pans in the muffle furnace, but in large plants a special melter is used for this purpose. The enamel itself consists of quartz, feldspar, borax and sometimes lead, manganese dioxide and cobalt oxide. The mixture is sintered in the muffle furnace for about 2 hr., dropped in water, broken up or allowed to cool in the pan, as the case may be, crushed and then milled.

The cover coat consists of silica, alumina, fluxes and opacifying materials which are smelted, run into water, dried and ground in porcelain-lined mills with porcelain balls. No flint pebbles should be used for dry grinding.

Crazing of the cover coat can be regulated in the mill by adding clay, tin oxide or zinc oxide. It can also be avoided by adding from 3 to 5 per cent of silica in the form of quartz without disturbing any of the other ingredients.

Preparation of Steel for Enameling

L. G. Whitford, of the Benjamin Electric & Manufacturing Co., made a short talk on the preparation of steel for enameling, a brief summary of which follows.

Many enameling shops receive the forms for enameling from outside shops. In such cases the enamel shop should always be sure that an order is made up from one and only one gage of steel, or much annoyance and loss will be experienced when the burning operation is performed.

As a preliminary, grease and oil are first removed by burning them off in a furnace or immersing the form in a chemical bath. If the piece is to be burned, it is first usually sprinkled with hydrochloric acid and held in the furnace until the piece is red hot. When a chemical bath is used, the material passes from the acid tank to a water tank, where it is rinsed and sponged by hand to remove the carbon film which remains on the surface after pickling. It is then passed into a neutralizing tank for a few minutes. Soda ash and caustic solutions are most commonly employed for this operation, one-tenth normal solution giving very good results. It then passes from the neutralizer tank to a drying room which is heated to 250 deg. F.

The most efficient cleaning solutions on the market consist of mixtures of caustic soda, soda ash, borax, trisodium phosphate, sodium chloride, rosin and soap. The action of these cleaning solutions is purely physical except in the saponification of the small amounts of animal or vegetable oils that might be present in some cases, cutting the oil away from the surface and emulsifying it. The bath is maintained at boiling or just below.

Selenium and Tellurium

By Victor Lenher*

A RECENT survey made by the Committee of the National Research Council on the uses of selenium and tellurium has shown that the electrolytic copper refining plants in this country, without making any material addition to their plants, can furnish approximately 300,000 lb. of selenium and about 125,000 lb. of tellurium per year. The uses of these elements in quantity are nil. They have a few minor uses. During the war selenium was used in considerable quantity for the decolorization of glass during the shortage of manganese. When the commercial ocean traffic was resumed and manganese was again brought to this country, the demand for selenium by glass companies dropped to practically nothing.

Small amounts of selenium are used in the manufacture of the selenium cell, which is unique in its action toward light. The conductivity of selenium varies so greatly in light and in darkness that this property of its conductivity varying directly proportional to the intensity of the source of light has found several industrial applications in the development of the selenium cell. This selenium cell has been used at various times for automatically turning off city gas lights at daybreak. It has been used to light and to extinguish the lights in light buoys, in army signaling of various kinds based on the heliograph principle, in the wireless telephone, and it has been used by the French as a control in such chemical processes as the contact sulphuric acid.

Metallic tellurium has not yet been found to have any practical applications of even minor importance.

Possible Uses for Selenium and Tellurium

Various possible uses for these elements have been suggested, but a considerable amount of research is desirable. For example: The use of either of the elements in the iron or steel industry. The field of organic medicinals with these elements has barely been touched. The physiological action in the derivatives similar to sulphur and selenium might well be studied. No experiments are recorded on the use of the chlorides or bromides of these elements as accelerators in the rubber industry, nor has the field of synthetic dyestuffs been studied carefully.

An address wes recently given by the writer at the St. Louis meeting of the American Chemical Society, suggesting a number of possibilities for the use of selenium oxychloride as a laboratory and research reagent. If this kind of chemistry can be developed by one new derivative of selenium, it is interesting to contemplate future possibilities in further researches with these elements.

The Engineering Division of the National Research Council has created a sub-committee on the uses of selenium and tellurium, consisting of Arthur E. Hall, chairman; H. G. Greenwood, Victor Lenher, O. C. Ralston, E. W. Rouse, S. Skowronski and A. W. Smith. This committee has been working in close contact with the Raritan Copper Works, Perth Amboy, N. J.; the United States Metals Refining Co., Chrome, N. J.; the American Smelting & Refining Co., Omaha, Neb., and the Baltimore Copper Smelting & Rolling Co., Baltimore, Md., which includes all of the producers of these elements in this country. These companies will furnish workable quantities of selenium and tellurium for research purposes at cost price.

E. W. Rouse, of the Baltimore Copper Smelting & Rolling Co., Baltimore, Md., will ship at any time reasonable quantities of selenium gratis to investigators upon the recommendation of the committee on the uses of selenium and tellurium of the National Research Council. Arthur E. Hall, of the Omaha plant of the American Smelting & Refining Co., will forward reasonable quantities of tellurium gratis under the same conditions.

In times past various prizes have been offered in Europe for work on the utilization of such elements as bromine and boron. These elements at one time had a very restricted use. Selenium and tellurium, though practically useless at present, will unquestionably find their place as a useful necessity to man, but a large amount of research work is, of course, necessary.

Madison, Wis.

*Professor of Chemistry, University of Wisconsin.

The French Iron and Steel Industry

The iron-ore resources of France before the war were estimated at 3,300,000,000 metric tons (metric ton = 2,204.6 lb.), or 300,000,000 tons less than those of Germany and 2,000,000,000 tons greater than England's. New basins have been discovered since 1910, and the French deposits, exclusive of those of Lorraine, are now estimated to be about 4,000,000,000 tons.

Aside from the new basins discovered, the relative resources of Germany and France (due to the recovery of the Lorraine basins) are at the present time: Germany about 1,270,000,000 tons and France 5,630,000,000. The exploitable iron-ore deposits of French North Africa (Algeria and Tunis) are estimated at from 100,000,000 to 150,000,000 tons.

The basins in the Departments of Meurthe-et-Moselle, Lorraine, Normandy, Anjou, Brittany and Pyrenees comprise the principal iron-ore deposits of France with an estimated tonnage of: Meurthe-et-Moselle, 3,000,000,000 tons; Normandy, Anjou, and Brittany, 200,000,000 tons; Pyrenees, 100,000,000 tons; Lorraine, 2,330,000,000 tons.

The production of iron ore in Germany, excluding Luxemburg but including Alsace-Lorraine, during 1913 was 28,608,000 metric tons, and in France, 21,918,000 tons. The estimates of possible production are: For Germany about 7,000,000 tons; and for France 43,000,000 tons and over, due to the recovery of Lorraine.

The principal iron- and steel-producing regions of France are:

The east, producing in 1912, 69 per cent of the pig iron, 55 per cent of the steel, and 43 per cent of the finished products.

The north, 17 per cent of the pig iron, 23 per cent of the steel, and 32 per cent of the finished products.

The center, 4 per cent of the pig iron, 12 per cent of the steel, and 14 per cent of the finished products.

The southwest, 5 per cent of the pig iron, 4 per cent of the steel, and 4 per cent of the finished products.

The west, 2 per cent of the pig iron, 3 per cent of the steel, and 4 per cent of the finished products.

The southeast, 3 per cent of the pig iron, 3 per cent of the steel, and 3 per cent of the finished products.

Alsace-Lorraine produced, in the first six months of 1919, 446 per cent of the iron, 32.1 per cent of the steel, and 28.4 per cent of the finished products manufactured in all France.

The Saybolt Viscosity of Oil Blends

A System of Charts for Determining Oil Blends of Components of Known Viscosity — Logarithmic Rule and Correction Factors to Be Applied in Calculations—Tables of Viscosities of Blends Containing 25, 50 and 75 Per Cent of Heavier Oil

BY WINSLOW H. HERSCHEL

AS IS well known, the viscosity of a blend of two oils is less than the arithmetical mean of the viscosities of the component oils, but "there appears to be no simple law connecting the viscosity of a mixture with that of its constituents."[1] A convenient diagram for determining the viscosity of blends has been given by Espy[2] for viscosities between 300 and 55 seconds, Saybolt, but no equation is given by which the diagram may be extended beyond the range of his experiments.

This investigation has shown that the formula of Arrhenius, as given by Dunstan and Thole,[3] is of considerable help when used with suitable corrections. This formula shows that the viscosity of a blend is the weighted geometrical mean between the viscosities of the component oils, and may be written

$$\log \mu = v_1 \log \mu_1 + v_2 \log \mu_2 \qquad (1)$$

where v_1 and v_2 are the percentage volume concentrations, and μ_1 and μ_2 are the viscosities of the component oils, expressed in the absolute unit of viscosity, the poise.

When the Saybolt Universal viscosimeter is used, the viscosity in poises may be calculated by the equation

$$\mu = \gamma\,(0.00220t - 1.80) \qquad (2)$$

where t is the time of flow, or Saybolt viscosity, in seconds, and γ is the density at the temperature of test, in grams per cubic centimeters.[4]

Since there is no definite relation between the viscosity and the density of oils (except when they are all from the same crude), and since it is generally assumed in the petroleum industry that two oils have the same viscosity if they show the same time of flow when tested in a viscosimeter, the effect of changes of density may be disregarded in approximate calculations.

Table I was calculated from equations (1) and (2) disregarding γ. It shows the Saybolt viscosities of blends containing 25, 50 and 75 per cent of either of the component oils. Each line of the table shows values of Saybolt viscosity for blends with a given viscosity of the lighter oil, the headings of the columns showing the viscosity of the heavier oil. Each rectangle formed by the intersection of a line and a column contains three values which are viscosities of blends of the two oils in question. Beginning at the top of a rectangle, these values are for blends containing 25, 50 and 75 per cent respectively of the heavier oil.

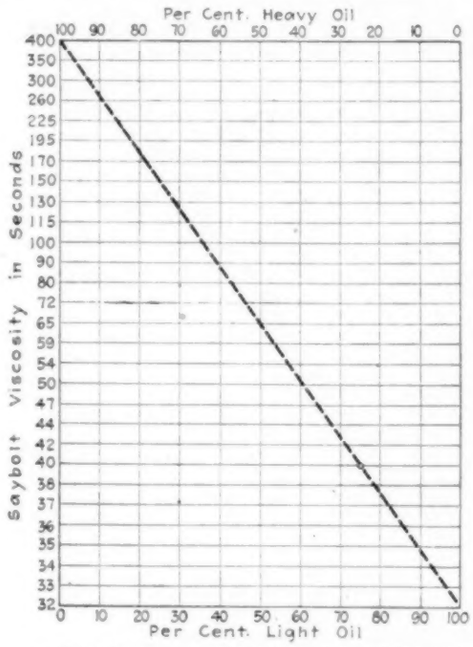


FIG. 1. CALCULATED VARIATION IN VISCOSITY OF A BLEND WITH THE VISCOSITY AND PER CENT OF OILS

Example: A blend of 40 viscosity, as shown by the point on the dotted line, may be made from 25 per cent of oil of 400 viscosity and 75 per cent of oil of 32 viscosity, both oils and blend being at the same temperature.

BLENDING CHART

On account of the large number of variables it is difficult to present Table I graphically. Fig. 1 is perhaps the most satisfactory form of diagram for a blending chart. Its form was due to Espy, but it was plotted from data of Table I.

According to Espy the data from a series of tests of two component oils mixed in all proportions are sufficient to enable a chart to be prepared which will be applicable to oils of all crudes. Higgins, however, made mixtures of Mexican with Scotch shale and Borneo oils, and found that the addition of 10 per cent of these latter oils caused the viscosity of the Mexican oil to be decreased 79 and 74 per cent in the two instances.

TESTS AT THE BUREAU OF STANDARDS

The first series of tests was made with two oils of approximately the same viscosities as those used by Espy and gave a fairly good check on his results. In order to get a large difference of viscosity between the two component oils, blends were made with gasoline and kerosene in Series 2. Equation (2) is not valid for viscosities less than 32 seconds, and for tests with gasoline it was necessary to use the Ubbelohde viscosimeter,[5] although the times of flow, as given in Table II,

[1] W. F. Higgins, Collected Researches National Physical Laboratory, vol. 13, p. 291; 1916.

[2] W. E. Espy, *Petroleum*, vol. 8, p. 27; 1919.

[3] A. E. Dunstan and F. B. Thole, The Viscosity of Liquids, p. 41; 1914.

[4] Winslow H. Herschel, *Proc.* A. S. T. M., vol. 18, Pt. II, p. 363; 1918; Technologic Paper No. 112, Bureau of Standards, p. 19; 1919.

[5] Winslow H. Herschel, Technologic Paper No. 125, Bureau of Standards, 1919; *Proc.* A. S. T. M., vol. 19, Pt. II, p. 676; 1919.

TABLE I. SAYBOLT VISCOSITIES OF BLENDS CONTAINING 25, 50 AND 75 PER CENT OF HEAVIER OIL, BOTH CONSTITUENTS BEING AT THE SAME TEMPERATURE AS THE BLEND

Viscosity Heavier Oil	35	40	45	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300	400	
		33	33	34	34	35	35	35	36	36	36	36	37	37	37	37	37	38	38	38	38	38	38	38	39	39	39	39	39	40	
		33	35	36	37	39	40	41	43	44	45	46	47	47	47	48	49	50	51	52	53	53	54	55	56	57	57	58	59	60	61	65	32
		34	37	40	42	46	50	54	58	62	65	68	72	75	78	81	84	88	91	93	96	99	103	106	109	112	114	117	120	123	150	
	322		36	37	37	38	39	39	40	40	40	41	41	41	42	42	42	43	43	43	43	43	43	43	44	44	44	44	44	45	46	
300	347		37	39	40	42	44	46	48	49	51	52	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	79	35
	372		38	42	44	49	54	58	63	67	71	75	79	83	87	91	94	98	101	105	108	111	115	118	122	125	128	131	135	138	170	
	314	293		41	42	42	44	45	45	46	47	47	48	48	48	49	50	50	50	51	51	51	51	52	52	52	53	53	53	54	55	
290	341	295		42	44	47	49	52	55	57	59	60	62	63	65	67	69	70	72	73	74	75	77	78	79	80	81	83	84	85	96	40
	369	297		43	47	52	58	63	68	73	78	82	87	91	95	100	105	109	113	117	121	125	129	133	137	140	144	148	152	155	191	
	305	285	282		46	48	49	50	52	52	53	54	55	56	57	57	58	58	59	59	60	60	60	61	61	62	62	63	63	64	66	
280	334	290	285		47	52	55	58	61	63	65	67	69	71	73	75	77	79	81	83	85	86	88	90	91	93	94	96	97	99	112	45
	366	294	287		49	56	61	67	73	78	83	88	93	98	102	107	112	118	122	126	130	135	139	143	148	152	156	160	165	169	208	
	297	277	274	272		52	54	56	57	58	59	60	61	62	63	64	64	65	65	66	66	67	67	68	68	69	69	70	70	71	74	
270	328	283	279	275		55	59	62	65	68	71	73	76	78	80	82	85	87	89	91	93	95	97	99	100	102	104	105	107	108	124	50
	362	290	284	277		57	64	70	76	82	87	92	98	103	108	113	118	124	128	132	137	142	147	151	155	160	164	168	173	177	220	
	289	272	269	266	263		62	63	65	66	68	69	70	71	72	73	74	75	75	76	77	77	78	79	80	80	81	81	82	82	87	
260	322	279	274	270	265		64	68	72	76	79	81	84	87	90	93	96	98	100	102	104	106	108	110	113	115	117	119	121	123	141	60
	359	289	282	275	267		67	74	80	87	93	99	105	110	115	120	126	131	136	142	147	152	157	162	166	171	176	181	186	191	235	
	280	261	259	257	255	252		72	74	75	77	78	80	81	82	83	84	85	86	88	89	90	91	92	92	93	94	94	95	96	102	
250	316	273	269	264	260	255		74	79	83	86	89	93	96	99	102	105	108	111	113	116	119	121	124	126	129	131	133	135	138	157	70
	355	285	278	271	264	257		77	84	91	98	102	109	115	121	127	133	139	144	150	155	160	165	170	176	182	187	192	198	202	249	
	272	253	251	249	247	244	242		82	84	86	87	89	91	92	94	95	97	98	99	100	101	102	102	103	104	105	106	106	107	115	
240	309	268	263	259	254	250	245		85	89	93	96	101	104	108	111	114	118	121	124	126	129	132	135	138	140	143	145	148	150	171	80
	352	283	276	269	262	255	247		87	95	101	106	115	120	126	133	139	144	150	156	162	168	173	179	185	190	196	201	206	212	260	
	264	245	243	241	239	237	235	233		93	95	96	98	100	101	103	105	106	108	109	110	111	112	113	114	115	116	117	118	119	128	
230	302	263	259	254	250	245	240	235		95	100	103	107	111	115	119	122	126	129	132	135	139	141	144	147	149	152	155	157	160	184	90
	348	280	273	266	259	252	245	238		97	105	111	118	124	132	139	145	150	156	162	168	174	180	186	192	197	202	208	213	219	271	
	255	237	236	234	232	229	227	225	222		103	105	107	109	110	112	114	115	117	118	120	121	122	123	125	126	127	128	129	131	139	
220	296	257	252	248	244	239	235	230	225		104	109	114	118	122	126	130	133	137	140	143	146	150	153	156	159	162	165	168	171	196	100
	344	276	270	262	256	249	242	235	227		108	115	122	129	135	142	148	155	161	168	174	180	186	192	198	204	209	215	220	226	279	
	246	229	227	225	224	221	219	217	215	212		112	114	116	118	120	122	124	125	127	129	130	131	133	134	135	137	138	139	140	149	
210	289	251	247	243	239	234	229	225	220	215		114	119	124	128	132	136	140	143	147	150	153	157	160	164	167	170	173	177	180	206	110
	340	274	267	260	253	246	239	232	225	217		117	124	131	138	145	151	158	165	171	178	184	190	196	202	208	214	220	226	232	287	
	237	221	219	218	216	214	211	209	207	205	202		121	124	126	129	131	133	135	136	138	140	141	142	144	145	146	147	148	149	160	
200	282	245	241	237	233	228	224	219	215	210	205		124	129	134	138	142	146	150	153	157	160	164	168	171	175	178	182	185	188	215	120
	335	270	263	257	250	243	236	229	222	215	207		128	135	142	149	156	162	169	176	182	188	195	201	207	213	219	225	231	237	293	
	228	213	211	209	208	206	204	201	199	197	195	192		132	134	136	138	140	142	144	145	147	148	150	151	153	154	156	157	158	170	
190	274	238	234	230	226	222	218	213	208	204	199	195		135	139	143	147	152	156	160	164	168	172	176	179	183	186	190	193	196	225	130
	331	266	260	253	246	240	233	226	219	212	205	197		138	145	152	159	165	172	179	185	192	199	205	211	218	224	230	236	242	300	
	219	204	202	200	199	197	195	193	191	189	187	185	182		142	145	147	149	150	152	154	155	157	158	160	161	163	164	166	167	180	
180	267	231	228	224	220	216	212	208	203	199	194	190	185		144	149	154	158	162	167	171	175	179	182	186	190	194	197	200	204	234	140
	326	263	257	250	244	237	230	223	216	208	201	194	187		147	154	161	168	175	182	189	195	202	209	215	222	228	234	241	247	306	
	210	195	194	192	190	189	187	185	183	181	179	177	175	172		152	155	157	159	161	163	165	167	168	170	172	173	175	176	178	190	
170	259	225	222	218	214	210	206	202	198	193	189	184	180	175		155	159	164	169	173	178	182	186	190	193	197	200	204	207	211	244	150
	321	260	254	247	241	234	227	220	213	206	199	192	185	177		157	165	172	179	186	193	200	207	213	220	226	232	239	245	252	311	
	200	187	186	184	183	181	179	177	175	174	172	170	167	165	163		163	165	167	170	172	174	175	177	179	181	183	184	186	187	200	
160	252	218	215	211	208	204	200	196	192	188	183	179	174	170	165		165	170	174	179	183	188	192	196	200	204	208	211	215	218	252	160
	316	256	250	244	237	231	224	217	210	204	197	190	183	175	168		168	175	183	190	197	204	210	217	224	231	237	244	250	256	316	
	400	300	290	280	270	260	250	240	230	220	210	200	190	180	170		170	180	190	200	210	220	230	240	250	260	270	280	290	300	400	

Viscosities of lighter oil over 160 vis. ← Viscosities of heavier oil, for lighter oils *over* 160 vis.

Viscosities of lighter oil less than 160 vis. → Viscosities of heavier oil, for lighter oils *less than* 160 vis.

NOTE.—The three values in each rectangle are viscosities of blends of the three percentage compositions given above.

have been computed for the Saybolt viscosimeter. If μ is the viscosity of a blend as calculated from equation (2) and μ' is the viscosity, in poises, as estimated from the viscosities of the two components, then $\frac{\mu}{\mu'}$ is a correction factor by which the viscosities, estimated by equation (1), must be multiplied to obtain the values as given by test. $\frac{t}{t'}$ is a corresponding correction factor for Saybolt viscosities. It will be noted from Table II that there is considerable difference between the correction factors for viscosities in poises and in Saybolt seconds for a given test at low viscosities, but that the difference becomes negligible at high viscosities. Table II also shows that the logarithmic rule does not indicate as low a viscosity of blend as found by test, and that the error is very great when there is a large difference in viscosity between the component oils.

Tests of Series 3 and 4 were made to determine the effect upon the correction factors of varying the crudes. In Series 3 two heavy oils, N and P, one of naphthene and the other of paraffine crude, were selected of approximately the same viscosity at the temperature of test, and blended with two lighter oils, M and Q of the same crudes. It was found that the maximum correction factor was obtained for a blend of N and Q and the minimum factor for P and M, and it is noteworthy that these are both blends of unlike crudes. Results of tests on these oils mixed in various proportions are given in Table III, and it is seen that the correction factors are lower when the heavy oil is of naphthene than of paraffine base.

Results Obtained When Using Kerosenes as Diluents

In order to see whether this rule was still valid when kerosenes of the two crudes were used as diluents, the tests of Series 4 were run with the results shown in Table IV. The letters showing the source of the oils have the same significance as in Table III, but the viscosities of the oils are different.

It is seen that the naphthene base oil, in Table IV, is

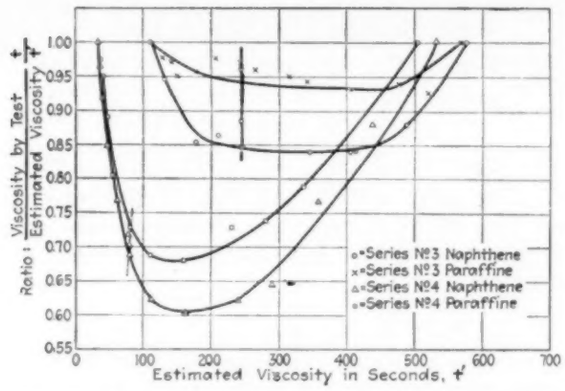

Ratio: Viscosity by Test / Estimated Viscosity
Estimated Viscosity in Seconds, t'
o=Series №3 Naphthene
x=Series №3 Paraffine
△=Series №4 Naphthene
○=Series №4 Paraffine

FIG. 2. THE RELATION BETWEEN THE VISCOSITY AS DETERMINED BY TEST AND AS ESTIMATED BY THE LOGARITHMIC RULE

"cut" (thinned out) to a greater extent than the paraffine base oil, but the difference is not so great as in Table III.

In both tables the blends containing component oils of the same crudes show values of the correction factors which are intermediate between the extreme values for blends of unlike crudes.

TABLE II. SERIES 2. TESTS OF 50 PER CENT BLENDS OF OILS FROM VARIOUS CRUDES WITH GASOLINE AND OTHER DILUENTS, AT 20 DEG. C. (68 DEG. F.)

Oils	Sp.Gr. 15.6°/15.6° C.	t	μ	$\frac{t}{t'}$	$\frac{\mu}{\mu'}$
1. Pennsylvania	0.864	259.7	0.485	.....	.....
2. Midcontinent	0.901	668.6	1.315	.....	.....
3. Texas	0.932	673.9	1.361	.....	.....
4. California	0.942	390.4	0.788	.....	.....
5. Mineral seal	0.832	54.0	0.0708	.....	.....
6. Kerosene	0.782	33.9	0.0172	.....	.....
7. Commercial gas	0.743	30.0*	0.0059	.....	.....
8. Aviation g s	0.700	28.8*	0.0036	.....	.....
50 per cent blends					
1 + 5	.....	95.4	0.1613	0.888	0.871
1 + 6	.....	53.3	0.0694	0.849	0.761
1 + 7	.....	38.8	0.0313	0.816	0.584
1 + 8	.....	36.0	0.0229	0.840	0.546
2 + 5	.....	130.8	0.2360	0.790	0.774
2 + 6	.....	59.6	0.0859	0.667	0.572
2 + 7	.....	41.2	0.0386	0.665	0.437
2 + 8	.....	39.4	0.0328	0.727	0.475
3 + 5	.....	117.9	0.2131	0.708	0.687
3 + 6	.....	56.1	0.0788	0.626	0.516
3 + 7	.....	39.8	0.0353	0.641	0.393
3 + 8	.....	35.4	0.0219	0.648	0.312
4 + 5	.....	104.6	0.1861	0.839	0.788
4 + 6	.....	53.1	0.0716	0.734	0.616
4 + 7	.....	38.2	0.0308	0.726	0.450
4 + 8	.....	34.7	0.0200	0.736	0.374

TABLE III. SERIES 3. TESTS OF BLENDS OF UNLIKE CRUDES AT 55 DEG. C. (131 DEG. F.)

Oils	Per Cent of Lighter Oil in Blend	Sp.gr. 15.6°/15.6° C.	t	μ	$\frac{t}{t'}$	$\frac{\mu}{\mu'}$
N + Q	100	0.885	111.5	0.1965	.....	.....
	90	.....	122.7	0.2202	0.945	0.940
	80	.....	134.0	0.2441	0.883	0.874
	70	.....	152.1	0.2817	0.853	0.845
	60	.....	181.1	0.3410	0.863	0.857
	50	.....	209.7	0.3990	0.846	0.842
	30	.....	290.2	0.565	0.839	0.837
	20	.....	343.6	0.674	0.847	0.837
	10	.....	424.0	0.838	0.873	0.877
	0	0.934	577.4	1.147	.....	.....
P + M	100	0.925	111.7	0.2060	.....	.....
	90	.....	126.6	0.2363	0.977	0.975
	85	.....	136.3	0.2557	0.972	0.971
	80	.....	144.2	0.2710	0.952	0.949
	70	.....	170.2	0.3220	0.958	0.957
	60	.....	203.8	0.3861	0.977	0.974
	50	.....	238.5	0.4520	0.971	0.968
	40	.....	278.9	0.530	0.960	0.962
	35	.....	299.7	0.568	0.950	0.951
	30	.....	323.2	0.612	0.943	0.945
	20	.....	377.1	0.710	0.930	0.931
	10	.....	445.6	0.836	0.936	0.936
	5	.....	481.1	0.901	0.925	0.923
	0	0.878	567.7	1.060	.....	.....
N + M	50	.....	219.5	0.4282	0.885	0.882
P + Q	50	.....	236.2	0.4376	0.962	0.959

TABLE IV. SERIES 4. TESTS OF BLENDS CONTAINING KEROSENE OF DIFFERENT CRUDES AT 20 DEG. C. (68 DEG. F.)

Oils	Per Cent of Lighter Oil in Blend	Sp. gr. 15.6°/15.6° C.	t	μ	$\frac{t}{t'}$	$\frac{\mu}{\mu'}$
N + Q	100	0.806	33.7	0.0166	.....	.....
	90	.....	35.2	0.0213	0.965	0.847
	80	.....	37.6	0.0286	0.918	0.750
	70	.....	41.1	0.0389	0.848	0.673
	60	.....	46.5	0.0537	0.767	0.613
	50	.....	55.6	0.0768	0.688	0.578
	40	.....	70.3	0.1115	0.623	0.554
	30	.....	98.7	0.1730	0.604	0.566
	20	.....	149.2	0.2803	0.621	0.606
	15	.....	189.0	0.3620	0.644	0.636
	10	.....	273.3	0.534	0.764	0.761
	5	.....	384.8	0.758	0.880	0.877
	0	0.911	534.8	1.064	.....	.....
P + M	100	0.808	33.8	0.0171	.....	.....
	90	.....	35.8	0.0231	0.976	0.904
	80	.....	39.0	0.0325	0.950	0.848
	70	.....	43.1	0.0438	0.891	0.765
	60	.....	48.6	0.0582	0.805	0.678
	50	.....	58.1	0.0815	0.728	0.634
	40	.....	75.8	0.1215	0.687	0.632
	30	.....	107.6	0.1886	0.679	0.654
	20	.....	168.4	0.3116	0.731	0.722
	15	.....	206.8	0.3872	0.738	0.733
	10	.....	267.5	0.506	0.789	0.783
	5	.....	346.2	0.662	0.839	0.836
	0	0.882	503.6	0.969	.....	.....
N + M	50	.....	57.4	0.0812	0.704	0.602
P + Q	50	.....	56.5	0.0776	0.716	0.612

Diagrams Used for Estimating the Correction Factors

Fig. 2 shows the results of tests of Series 3 and 4. It will be noted that the time ratio, or correction factor, is not a minimum for the 50 per cent blends, which are indicated by vertical dotted lines. While this form of diagram is convenient for interpolation in a given series of tests, it is not convenient for interpolation between one series and another.

In order to reduce the number of variables, it was decided to concentrate attention upon 50 per cent blends. If the correction factor for this blend is known, the factors for other proportions may be estimated by sketching curves similar in shape to those of Fig. 2.

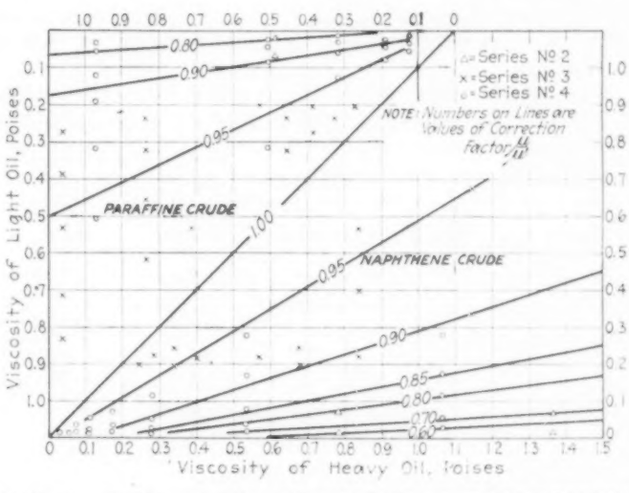

Viscosity of Light Oil, Poises
Viscosity of Heavy Oil, Poises
△=Series № 2
x=Series № 3
○=Series № 4
NOTE: Numbers on Lines are Values of Correction Factor μ/μ'
PARAFFINE CRUDE
NAPHTHENE CRUDE

FIG. 3. DIAGRAM FOR ESTIMATING THE CORRECTION FACTOR FOR VISCOSITIES CALCULATED BY THE LOGARITHMIC RULE

The use of the correction factor $\frac{\mu}{\mu'}$ eliminates density and makes results more concordant than when $\frac{t}{t'}$ is used.

A blend of any proportion may be considered as a 50 per cent blend of two other blends, as for example, a 20 per cent blend is a blend of two others, one con-

taining 10 and the other 30 per cent of the component in question.

By estimating the viscosity of the 20 per cent blend from the experimentally determined viscosities of the 10 and 30 per cent blends, a new correction factor may be determined. Fig. 3 was plotted from correction factors obtained in this way.

The figure is divided into two sections by the diagonal line marked 1.00, the upper portion being for the blends P + M and the lower for N + Q. In plotting the diagram each point was marked with the corresponding value of $\frac{\mu}{\mu}$ (not shown) and the lines drawn to conform as well as possible with these values, as in making a contour map.

Excluding steam-engine cylinder oils, and oils that are of too low a viscosity to be used in actual blending operations, the range is from about 1.5 to 0.12 poise. In the extreme case, therefore, the correction factor from Fig. 3 would be 0.75 for naphthene and 0.80 for paraffine crudes, corresponding to errors in viscosity of 33 and 25 per cent respectively. The errors in Saybolt viscosity would be somewhat less.

The estimation of the viscosity of blends containing cylinder stock presents an additional difficulty on account of the error in measurement of viscosities due to the change of volume of the oil after leaving the outlet tube. There is thus a possibility of serious disagreement between viscosities estimated by the use of Fig. 3 and experimental results, when cylinder stock is used at temperatures approaching the boiling point of water, unless precautions are taken to avoid the error above mentioned.

Conclusion

A table of viscosities of blends has been calculated from the logarithmic rule which is inaccurate but is the best available. The larger the difference in viscosity of the component oils the greater will be the error in the rule. For equal differences of viscosity the error increases as the viscosity of the lighter component decreases.

Diagrams are given for finding the correction factor for 50 per cent blends, and for then estimating the correction factors for blends of other proportions.

U. S. Bureau of Standards.

A Bankrupt Philosophy

"My emphatic conclusion is that Socialism as a philosophy of possible human application is bankrupt. The whole of the various sorts of Socialism are based on one primary conception, and that is that the productivity of the human being can be maintained under the impulse of altruism, and that the selection of the particular human for this most productive performance can be made by some superimposed bureaucracy. Their weakness is the disregard of the normal day-to-day primary impulse of the human animal—that is, self-interest for himself or for his family and home, with a certain addition of altruism varying with his racial instinct and his degree of intelligence. They fail to take into account, also, that there is but one sufficiently selective agent for human abilities in that infinite specialization of mind and body necessary to maintain the output of the intricate machinery of production, and that is the primary school of conception."—Herbert Hoover, in *The Nation's Business.*

Peat Fiber and the Textile Industry

Swedish efforts to introduce peat fiber as a substitute article in the textile industry have come to naught for the moment. It is the consensus that the prices for extracting the fiber from peat moss must be economical before it will ever come into general use. Two factories, one in Denmark and the other at Partille, near Goteborg, both established during the war for the purpose of utilizing peat fiber, have had to close their doors in recognition of this fact.

One of the leading exponents of the uses of peat fiber was Prof. Gustaf Sellergren, of Stockholm. It was upon his application that the Swedish Government recently caused an investigation regarding the possibilities of utilizing the vast deposits of peat moss in Sweden in the textile industry of the country. The experts appointed to make the investigation have completed their labors, and, among other things, found:

(1) Good textiles of peat fiber and "shoddy" can be manufactured and samples were demonstrated, but

(2) The Swedish peat mosses can produce only 100 kilos of fibers and moss per day, which is not sufficient for commercial purposes.

(3) The methods so far used in obtaining the fibers are too expensive.

The experts concluded by proposing that no further action be taken in the matter until the peat mosses could be examined carefully with regard to the amount of fiber contained, which work is within the province of the Swedish Committee on Geological Examinations and the government's peat engineers serving in the Swedish Department of Agriculture.

Prof. Sellergren states, however, that his methods have not been tried, and that his patent rights for Sweden already have been sold. He claims to have some very fine samples of textiles made of peat fiber, and says that while his interest in this fiber has been cooled by the findings some day he may return to the subject. He claims that Swedish peat mosses contain on an average 15 to 20 per cent peat fibers and that they should be utilized in connection with the fabrication of peat litter.

Treatise on Pyrometric Practice

The Bureau of Standards has completed the manuscript of a comprehensive treatise on modern pyrometry under the title "Pyrometric Practice." The object of this treatise is to provide investigators, manufacturers and others who may be concerned with the measurement of high temperatures with complete information as to the present state of the art of pyrometry, the instruments and methods used, the precautions that must be observed to obtain correct results, and to illustrate some of the industrial applications of pyrometry. The scope of the paper is indicated from the following subheads: Temperature scale; high temperature thermometry; thermal electrical pyrometry; optical pyrometry; radiation pyrometry; resistance thermometry; recording pyrometry; high temperature control; melting point methods at high temperatures; standardization of pyrometers and industrial applications of pyrometry. This paper will be ready in six to nine months. The completed volume will consist of 300 pages and will contain a large number of illustrations. The number for free distribution will probably be small, but provision will be made by which it can be obtained at cost from the Superintendent of Documents.

Elastic Properties of Bronze Castings

A Series of Tests Showing That a Definite Proportional Limit Can Easily Be Found for Bronzes, and the Suggestion Made That This Test Should Replace the More Usual but Illogical "Yield Point" Determinations

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IN COMMERCIAL practice it has become customary to determine the so-called "elastic limit" or yield point of non-ferrous alloys as the tensile stress producing a deformation of 0.01 in. on a gage length of 2 in. The chief advantages of this method are its ease of application and the facility with which concordant results can be obtained by different operators on the same material. It is generally conceded that the "drop-of-the-beam" method, which is used for rolled soft steel, cannot be applied to non-ferrous alloys; and if the smallest appreciable deformation is taken as the criterion of the yield point, difficulties are at once encountered in agreeing as to what constitutes an appreciable deformation. Thus the figure of 0.01 in. has been recommended and apparently agreed upon as representing the smallest practical deformation that can readily be measured with dividers in determining the so-called "elastic limit" of non-ferrous alloys.

It is a question, however, whether this determination really gives us any information of value. It is intended, of course, to show the stiffness of the material, and what stress it would safely bear in service without bending or stretching. Yet it is obvious that the yield-point stress as so defined is appreciably more than enough to start deformation in the metal, and there is no way of telling from this determination at what stress the deformation really began. For trustworthy information on this point it is necessary to determine the true elastic limit or proportional limit of the material, and the accustomed use of the yield point in this connection is not correct, as there is no direct relation between it and the proportional limit. As has been stated by J. A. Capp in his paper on "The Elastic Limit of Manganese and Other Bronzes," before the American Society of Mechanical Engineers in 1910, "The real object of testing is to determine the characteristics of a material so that one may decide what shall be safe stresses in any structure, taking into account the elastic properties of the material, etc. Usually such safe loads are a certain proportion of the elastic limit. If, however, the elastic limit is determined by erroneous tests to be double its true value, any calculation based on such data is utterly unsafe."

This same idea applied to steel was enlarged upon by A. N. Mitinsky in "Some Suggestions Regarding the Determination of the Properties of Steel," published in the *Bulletin* of the American Institute of Mining Engineers for August, 1915, p. 1,697, but the author probably carried it a little too far in claiming that fatigue resistance is determined solely by the proportional limit, and that the wear of rails is also dependent on it.

The best definitions of elastic limit, proportional limit and yield point are undoubtedly those given by the American Society for Testing Materials in its "Standard Methods of Testing," and it is assumed that they are sufficiently well known not to require repetition here. Reference should also be made to the discussion on elastic limit, etc., in the *Proceedings* of this Society, vol. 16, part 2, p. 404. Some writers, as Howard, Upton in "Materials of Construction," and Thurston in "Materials of Engineering," do not make any distinction between elastic limit and proportional limit. Others, such as Lynch, Olshausen and Moore, hold that there is a difference between these limits, the true elastic or "set" limit being higher. Moore feels that the difference may be due to initial stresses in the material, or the limits of precision of the apparatus, or other similar causes. He has also stated that the determination of the proportional limit depends in no small degree on the sensitiveness of the apparatus used; while Morse, on the other hand, claims that in determining the proportional limit an extensometer of low precision gives the same result as one of high, though the latter is necessary for the elastic limit.

Elastic Behavior of Non-Ferrous Metals

The idea that ductile non-ferrous metals, especially in the cast condition, do not have any definite elastic limit, proportional limit or yield point is quite prevalent in the literature. For instance, in Upton's "Materials of Construction" the statement occurs (p. 23) that "there is no very definite elastic limit" in castings of ductile materials tested parallel to their surfaces or lengths, but in this case "the loading line is slightly curved from the beginning." Also he says (p. 29) that "the ductile materials other than steels usually have either non-isotropic crystals or very large initial internal stresses. These conditions prevent the fairly simultaneous yielding of all parts of the structure. The beginnings of yielding of the individual crystals are distributed over a considerable range of the loading. So in brasses and bronzes, for instance, we miss the decided yield-point action of the steels." Thurston, in his "Materials of Engineering" (part 3, p. 245), even goes so far as to say that non-ferrous metals "have usually, as purchased, no true elastic limit, but yield to small stresses without recovery of form, and their permanent set equals their maximum distortion." C. A. M. Smith, in a paper before the Institute of Metals on "The Elastic Breakdown of Non-Ferrous Metals" (*Journal*, vol. 2, p. 151), reported variable results obtained with his very delicate "sphingometer" for the measurement of minute strains, but in the discussion Parker stated that while lack of homogeneity in cast non-ferrous alloys probably accounted for 75 per cent of the cases of inequality of stress distribution in testing, yet in spite of this the elastic limit was not greatly affected.

This belief that cast non-ferrous metals do not have any real elastic limit, or any definite limit of proportionality of strain to stress, is one reason for the adop-

tion of the arbitrary criterion of 0.5 per cent elongation as marking the so-called "elastic limit" or yield point to be used in ordinary commercial work. Another reason is the assumption that the determination of the real elastic limit or proportional limit is too difficult for this class of work, and involves the use of expensive and delicate apparatus and considerable time. Corse and Skillman evidently took this attitude in their paper on "Manganese Bronze Tests" before the Eighth International Congress of Applied Chemistry (vol. 3, p. 25), for although urging that the usual yield-point determinations on this material are useless, they do not suggest taking the proportional limit instead, but would rely entirely on the tensile strength and elongation. Capp, in his paper on Manganese Bronze quoted above, considered not only that a delicate extensometer was necessary for proper determinations of the proportional limit, but that the gage lengths of the test bars should be 8 in. Nearly all authorities agree that this test must be made with spherical-seated holders for the specimen, and with an accurate extensometer averaging the deformations on two or three sides of the bar, and even then it is claimed by some that non-homogeneity of the specimen and inequality of stress distribution may obscure the real effects of inelastic action in the results. Therefore it has come about that proportional limit determinations have been considered as too refined and expensive for the ordinary commercial tests of bronzes, and the easier but almost worthless yield-point method has been retained instead.

Elastic Tests on Bronzes

During the past few years quite a large number of tests have been made in this laboratory on several types of cast bronze alloys with a view of determining fairly closely their true elastic properties. The measurements of elastic limit and proportional limit have been made in different ways, and although the instruments used have been of the simplest type, the results have been so consistent as to be of interest in showing what can be done along this line with almost crude equipment. It has also been brought out how truly deceptive the commercial yield-point determination is, and the results are probably worth emphasizing merely to prevent undue reliance being placed upon that determination. Another point which it is believed has been demonstrated is that ductile non-ferrous alloys, even when cast, do have a definite limit of proportionality of strain to stress.

A variety of alloys was used in this work, but the most complete results were obtained from manganese bronze, aluminum bronze with 10 per cent aluminum and 1 or 4 per cent iron, and the common gun-metal or zinc bronze of about 88-10-2 composition, including both the G and Pc2 specifications of the Navy Department, the latter allowing a much wider range of tin and an appreciable lead content. The manganese-bronze test specimens were cast in the form of keel-blocks, the aluminum-bronze as plain round bars, and the zinc-bronze specimens were cast in nearly the final size and shape, and fed through a lengthwise fin. The test specimens were all machined to approximately ½-in. diameter between shoulders, and the gage length was in all cases 2 in. A few tests were made with specimens having plain ends, and pulled in ordinary wedge grips, but the results obtained in this way were too irregular, and it was soon recognized that the specimens must be pulled in grips having spherical seats through which the tension would be applied without any bending. The grips used here were fitted to receive a specimen with threaded ends, but similar grips intended to engage with extra shoulders on the ends of the specimens would probably be equally satisfactory.

The testing was all done with an Olsen Universal three-screw machine of 100,000-lb. capacity, but the lighter poise reducing the capacity to 10,000-lb. was used for nearly all the work below the yield point in order to increase the delicacy of the load measurements. The autographic mechanism supplied with this machine for drawing load-deformation diagrams was rejected as not being sufficiently sensitive with gage lengths of only 2 in., and a Berry strain gage was used in its place. Several methods of applying this instrument were tried. At first it was clamped to the test specimen and used as an extensometer, as shown in Fig. 1, the deformations in this case being read on only one side of the specimen. Although this method is not favored by most writers on this subject, it has been defended by J. J. Shuman in discussing Lynch's paper on "Elastic Limit" (*Proc.* A. S. T. M., vol. 15, part 2, p. 417).

Results With Strain Gage in One Position

In the first series of tests of cast specimens (not heat treated) the loads were applied in increments of 200 lb., the strain gage reading for the load was taken, and the load was removed to get the permanent set. This procedure was repeated for each load until the permanent set became about 0.0003 in.; after that the loads were not removed between increments, and the deformation only under load was measured each time. When this became greater than 0.01 in. the strain gage was removed, and the test specimen was broken in the usual way. The strain gage was graduated to 0.0002 in., and

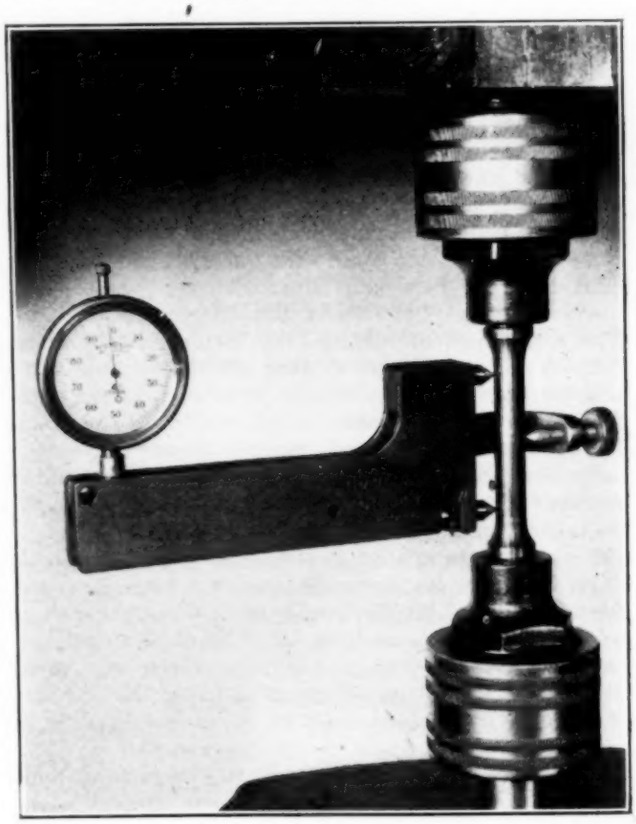


FIG. 1. BERRY STRAIN GAGE, AS USED IN THE FIRST SERIES OF TESTS

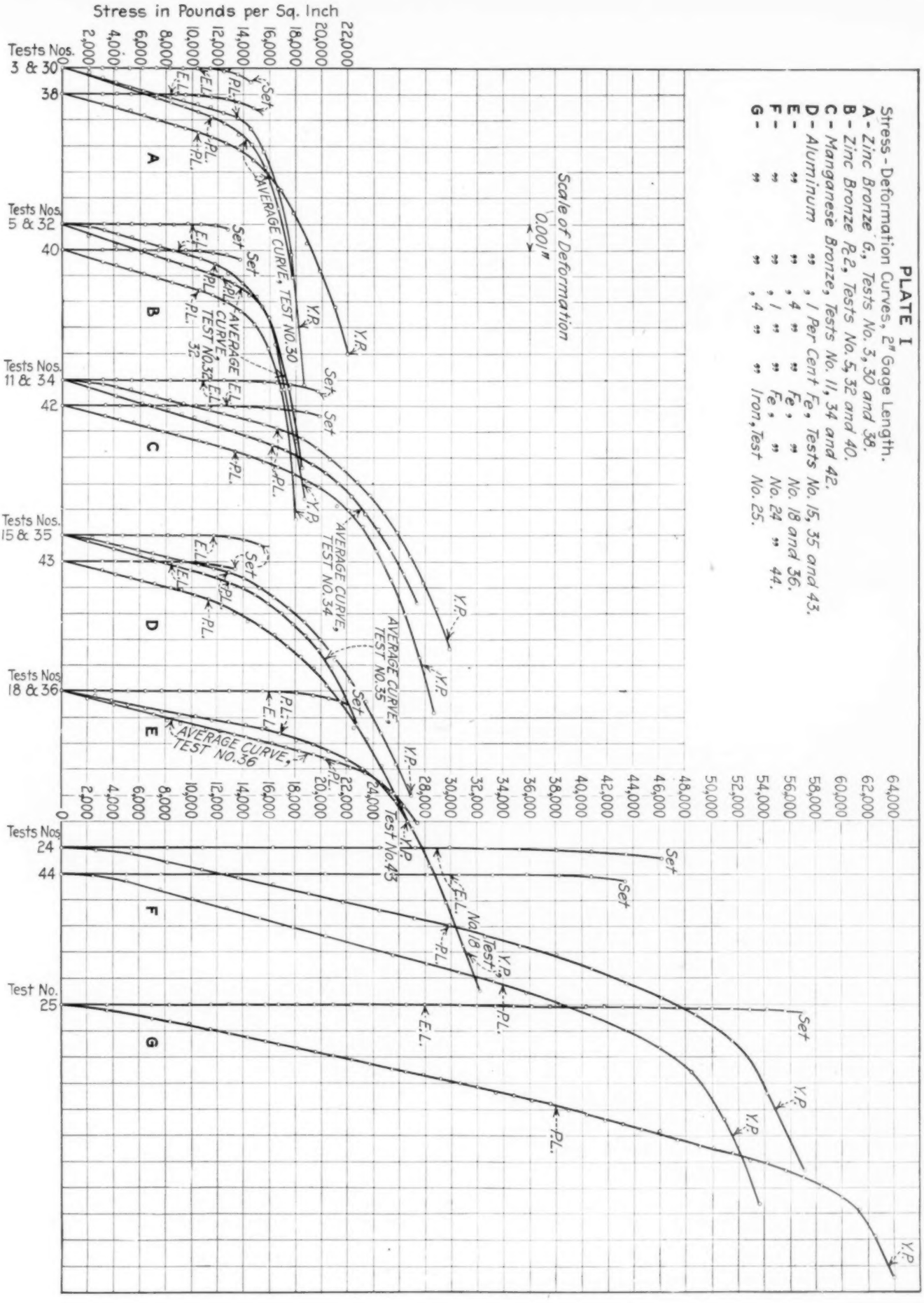


PLATE I

Stress - Deformation Curves, 2" Gage Length.

A - *Zinc Bronze G., Tests No. 3, 30 and 38.*
B - *Zinc Bronze R.2, Tests No. 5, 32 and 40.*
C - *Manganese Bronze, Tests No. 11, 34 and 42.*
D - *Aluminum* " , 1 Per Cent Fe, Tests No. 15, 35 and 43.
E - " , 4 " " Fe, " No. 18 and 36.
F - " , 1 " " Fe, " No. 24 " 44.
G - " , 4 " " Iron, Test No. 25.

the readings taken were estimated to a tenth of this value, or 0.00002 in. The stress-set and stress-deformation curves were plotted on cross-section paper to a scale such that 1 in. vertically represented 5,000 lb. per sq.in., and 1 in. horizontally represented 0.002-in. extension on the gage length of 2 in., or 0.1 per cent deformation.

Tests on the heat-treated aluminum-bronze test specimens were made in the same way, except that a heavier poise was used on the machine, the increments were 500 lb. instead of 200, and the stress scale used in plotting was such that 1 in. represented 10,000 lb. per sq.in.

The results were obtained from the curves in the following way: The yield point was the stress at which the deformation curve crossed the line representing 0.01-in. extension, and the proportional limit was the stress at which this curve ceased to coincide with a straight line drawn through most of the points at the lower part of the curve. The elastic limit was the stress at which the set curve departed from an approximately vertical direction, sets of 0.00002 in. being generally neglected unless the next set recorded was considerably greater. The tensile strength, elongation and reduction of area were determined in the usual way after removing the strain gage and breaking the specimen. The moduli of elasticity were also read from the curves, but were not considered reliable, as will be explained below.

The results obtained in this way are listed in Table I, and some of the curves noted by a star and typical of each alloy are also illustrated in Plate I. The figures given represent pounds per square inch, or, in the case of the elongation and reduction of area, per cent.

Results Using Strain Gage in Three Positions

In all these tests it was found that the elastic limit was lower than the proportional limit, except in a few cases where both appeared about equal. According to most authorities, however, the elastic limit, if not equal to the proportional limit, should be slightly higher. Consequently the possibility of serious error in the above results was feared, and it was felt that this might have arisen from the manner of using the strain gage, that is, along one line only of the test specimen. Furthermore, many of the deformation curves were not as regular as might be desired, although the proportional limit was quite distinctly marked in all of them. To check the accuracy of the proportional limits tabulated above, it was therefore decided to test other specimens of these alloys, with the strain gage applied successively to each of three gage lines, equal distances apart around the surface of the specimen, for every load used. The test specimens were prepared, and held in the testing machine, in the same way as was previously described, but the loads used were 400, 800, 1,200, and every 200 lb. above that until the proportional limit had surely been passed. The gage was placed in each of three pairs of punch marks by hand three or four times at each load, and the average reading for each pair of marks was recorded. Considerable care was necessary in holding and reading the gage in this way, for the reading could be varied appreciably by changing the manner of applying the gage. It was not thought practical to drill holes into the specimens for the reception of the gage points, for with a small specimen such as was used in this work, premature failure would be almost certain to occur through the drilled holes. The loads were not released in these tests to determine the permanent sets, because it was not thought possible to apply the gage to the specimens accurately enough by hand to measure the very minute differences in length that these sets represent; also because attempts to get these measurements would have consumed very much more time. Therefore elastic limits are not reported for this series, and these tests were not carried far enough with the strain gage to get the yield points.

Three stress-deformation curves were obtained by this method for each specimen, and they were plotted to the same scale as has been described above. An average curve was also plotted by using the average deformation at each load, and it was always more regular in form than the three curves of actual measurements.

TABLE I. RESULTS USING STRAIN GAGE IN ONE POSITION

Test	Elastic Limit	Proportional Limit	Yield Point	Tensile Strength	Elongation, Per Cent	Reduction of Area, Per Cent
			Zinc-Bronze, Alloy G			
1	12,000	14,000	19,000	44,000	38.5	28.6
2	12,500	14,500	19,800	35,800	17.5	20.2
3*	10,500	13,500	18,100	42,000	31.5	31.0
4	9,000	15,000	20,600	38,700	18.5	16.4
Average,	11,000	14,200	19,400	40,100	26.5	24.1
			Zinc-Bronze, Alloy Pc2			
5*	10,000	11,500	18,400	37,200	26.0	24.8
6	8,500	10,000	21,000	46,200	34.0	26.8
7	10,000	14,000	19,500	46,200	31.0	27.9
8	9,000	13,000	19,800	36,000	15.0	14.9
Average,	9,400	12,100	19,700	41,400	26.5	23.6
			Manganese-Bronze			
9	13,500	17,000	26,900	74,900	32.0	28.7
10	14,000	17,500	29,800	82,300	22.0	20.9
11*	11,000	16,500	29,700	78,500	17.5	15.4
12	10,000	15,500	26,500	73,400	31.0	28.6
Average,	12,100	16,600	28,200	77,300	25.6	23.4
			Aluminum-Bronze, 1 Per Cent Fe			
13	12,000	13,000	27,100	67,500	20.0	20.9
14	10,500	12,500	27,500	77,600	21.0	20.6
15*	11,500	13,000	26,900	72,100	20.5	22.2
16	11,000	12,000	25,200	74,300	26.5	27.0
Average,	11,200	12,600	26,700	72,900	22.0	22.7
			Aluminum-Bronze, 4 Per Cent Fe			
17	17,000	17,500	33,100	84,600	18.5	18.2
18*	16,000	17,000	31,200	68,000	10.0	15.1
19	17,500	19,500	33,000	(Spoiled by flaw)		
20	13,500	16,500	31,300	89,600	25.5	22.6
Average,	16,000	17,600	32,100	80,700	18.0	18.6
			Aluminum-Bronze, 1 Per Cent Fe, Heat Treated			
21	23,000	28,000	53,500	85,600	12.5	15.4
22	23,000	27,000	55,800	97,400	15.0	19.6
23	29,000	39,000	65,500	92,700	7.5	10.3
24*	29,000	30,000	55,000	95,700	15.5	13.9
Average,	26,000	31,000	57,400	92,800	12.6	14.8
			Aluminum-Bronze, 4 Per Cent Fe, Heat Treated			
25*	28,000	38,000	63,600	107,400	19.0	21.0
26	36,000	39,000	56,000	90,300	12.0	12.9
27	25,000	39,000	61,300	99,500	11.0	12.9
28	28,000	29,000	57,000	102,900	22.0	22.0
Average,	29,200	36,200	59,500	100,000	16.0	17.2

*Illustrated in Plate I.

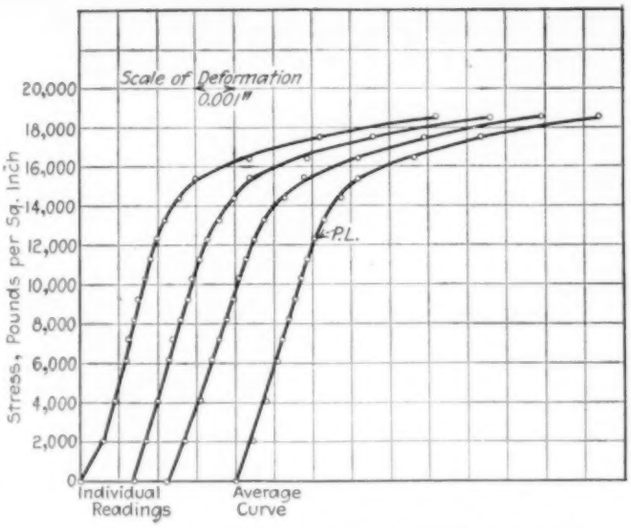


FIG. 2. STRESS-DEFORMATION CURVES FOR ZINC-BRONZE Pc2, TEST 32. GAGE LENGTH, 2 IN.

The true proportional limit and modulus of elasticity were determined from it, the latter being the stress divided by the extension per inch, for any point on a straight line drawn through most of the points of the lower part of the average stress-deformation curve. The results are presented in Table II in the same form as before, and typical average curves noted by a star for each alloy are also illustrated in Plate I.

TABLE II. RESULTS WITH STRAIN GAGE IN THREE LOCATIONS

Test No.	Proportional Limit	Modulus of Elasticity	Tensile Strength	Elongation, Per Cent	Reduction of Area, Per Cent
		Zinc-Bronze, Alloy G			
29	8,000	11,000,000	33,800	21.5	22.9
30*	11,500	12,500,000	33,600	15.5	13.9
		Zinc-Bronze, Alloy Pc2			
31	11,000	13,500,000	35,400	22.0	23.9
32*	12,500	12,000,000	39,200	27.0	26.8
		Manganese-Bronze			
33	18,500	13,000,000	83,200	24.0	22.4
34*	16,500	13,000,000	85,700	25.0	21.8
		Aluminum-Bronze, 1 Per Cent Fe			
35*	13,000	14,500,000	72,700	29.0	26.1
		Aluminum-Bronze, 4 Per Cent Fe			
36*	20,500	16,000,000	71,000	9.0	10.4

* Average curves for these samples listed in Plate I.

In explanation of Table II it should be noted that both of the Alloy G specimens (tests 29 and 30) turned out to be unsound, so that their lower proportional limits

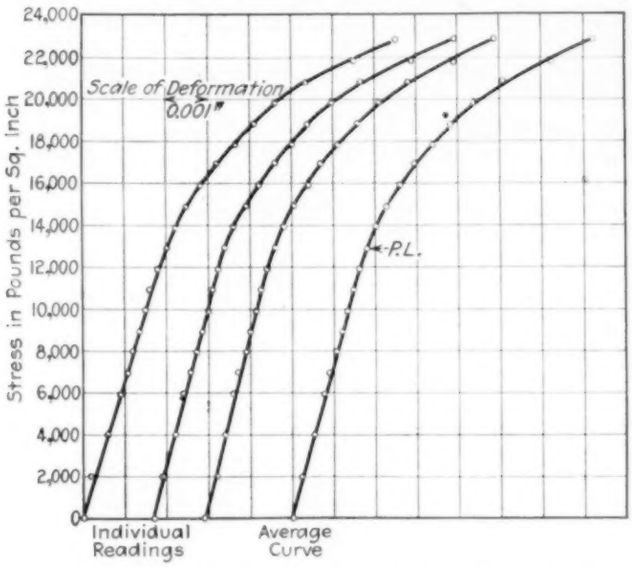


FIG. 3. STRESS-DEFORMATION CURVES FOR ALUMINUM-BRONZE, WITH 1 PER CENT Fe, TEST 35. GAGE LENGTH, 2 IN.

as compared with the previous tests (Nos. 1 to 4) might be expected. Also the specimen of aluminum-bronze with 4 per cent iron had been cast in sand 1¼ in. in diameter, and had been allowed to cool too slowly, so that it was somewhat annealed. This lowered the strength and ductility but raised the proportional limit. With these explanations the proportional limits check in a satisfactory manner those determined by using the strain-gage as an extensometer. It may be noted, moreover, from all the curves, such as those for zinc-bronze, alloy Pc2 (illustrated in Fig. 2) and for the aluminum-bronze containing 1 per cent iron (Fig. 3), that in the case of every specimen a proportional limit determined from one of the individual strain-gage curves would be just the same as the result found from the average

FIG. 4. HOME-MADE EXTENSOMETER, WITH AMES DIAL FROM BERRY STRAIN GAGE, SHOWING METHOD OF USE IN THE THIRD SERIES OF TESTS

curve for that specimen. This shows that no serious errors occurred in the proportional limit determinations of the first series of tests because of the use of the gage along only one line on the surface of each specimen. This is seen not to hold true for the modulus of elasticity, however, as the slopes of the individual curves vary considerably (Figs. 2 and 3), which shows that no true idea of this modulus can be obtained from the first series of tests. The curves from the heat-treated aluminum-bronzes were so regular and uniform that it was not thought necessary to check them in the second series.

Results Using Special Extensometer

Some of the individual curves of the second series were very irregular in their lower portions, on account of the great difficulty of placing the strain gage on exactly the same marks on the specimen accurately for each measurement. To eliminate this trouble, and to check the elastic limit and modulus of elasticity figures already obtained, an extensometer was constructed that could be kept attached to the specimen till after the yield point was passed, and that would measure the average deformation along two sides of the specimen. The same dial was used in the extensometer as in the strain gage, and the frame of the extensometer was constructed somewhat on the pattern of the instrument described before the Society for Testing Materials in 1915 by S. H. Graf (*Proc.* A. S. T. M., vol. 15, part 2, p. 376). In our instrument shown in Fig. 4, however, the motion transmitted from the test specimen to the dial is magnified five times by levers, as is done in the strain gage

itself, so that a unit on the dial represents the same deformation of the specimen, whether it is on the strain gage or on the extensometer.

Tests were made with this extensometer in exactly the same way as was described above for the first series of tests, the only difference being that the deformations measured in this third series were average deformations from two sides of the specimen, instead of being from only one side. The curves obtained in this way were more regular, and determinations were made of the elastic limit and modulus of elasticity as well as the proportional limit, yield point, etc. The results are listed in Table III and some typical curves noted by a star are also shown in Plate I.

TABLE III. RESULTS USING SPECIAL EXTENSOMETER

Test No.	Elastic Limit	Proportional Limit	Modulus of Elasticity	Yield Point	Tensile Strength	Elongation, Per Cent	Red. of Area, Per Cent
			Zinc-Bronze, Alloy G				
37	10,500	10,500	11,500,000	17,000	37,300	30.0	26.2
38*	8,500	10,500	13,800,000	22,000	32,900	15.0	20.0
			Zinc-Bronze, Alloy Pc2				
39	7,500	10,000	11,500,000	17,600	35,700	27.0	33.2
40*	9,000	10,500	13,500,000	17,900	35,800	24.0	30.2
			Manganese-Bronze				
41	13,500	13,500	16,000,000	29,600	77,600	20.5	21.8
42*	12,500	13,500	15,400,000	27,800	73,000	25.5	23.8
			Aluminum-Bronze, 1 Per Cent Fe				
43*	8,500	11,000	15,500,000	26,600	73,400	20.5	21.6
			Aluminum-Bronze, 1 Per Cent Fe, Heat Treated				
44*	30,000	34,000	15,000,000	51,600	81,800	9.0	16.5

* These curves shown in Plate I.

Discussion of Results

Allowing for individual variations in the test specimens, these results are in fairly good agreement with those given before. The proportional limits are nearly all lower than in the other series, but most of these specimens were of somewhat softer material as shown by the tensile strengths. The elastic limits check those in the first series, and the moduli of elasticity agree with those in the second series, except in the case of the manganese-bronze, where there is a considerable difference probably due to a different quality of metal.

It seems quite evident from this work that the elastic limits of these cast bronzes are nearly always found lower than the proportional limits, and never higher. The writer does not attempt to explain or defend this statement on theoretical grounds, but the curves certainly seem to demonstrate its truth.

Another point brought out clearly by the curves and tables is that there is no uniform relation between the proportional limit and the yield point or tensile strength in these alloys. Comparing tests 37 and 38, for instance, the latter showed a decidedly higher yield point (and modulus of elasticity) due to separation of the copper-tin eutectoid in greater amount, but its real proportional limit was as low as in the other specimen. Also the zinc-bronzes have distinctly lower yield points and much lower tensile strengths than aluminum-bronze with 1 per cent iron, yet the proportional limits of these two alloys are practically the same. When heat treated, however, the aluminum-bronzes are far superior to any of the other non-ferrous alloys in elastic properties, and the method of treatment leaves them free from internal stresses so that their proportional limits are very distinct and easily recognized.

No claim can be made for exceptional accuracy in these tests, but it has been demonstrated that a definite proportional limit can be found for non-ferrous castings without any great refinements of testing such as would be impractical in commercial work. When it is not desired to determine the elastic limit or modulus of elasticity, the proportional limit can be found with little trouble by means of a Berry strain gage attached to the test specimen and used as an extensometer. It is necessary, however, to pull the specimen with spherical-seated holders.

Of course any of the good extensometers on the market can be used with at least equally good results, and any of the methods for proportional limit determinations that have been described before the Society for Testing Materials may be followed.

It is suggested that for acceptance tests of non-ferrous castings the rough determination of the yield point as the stress giving a deformation of 0.5 per cent should be discarded as of no real significance, and that the importance of tensile strength measurements for this class of material should also not be emphasized, but that proportional limit determinations should be made and used for acceptance or rejection of bronzes that are intended to resist stresses in service. Ductility as expressed by a good percentage of elongation is probably a necessary quality to guard against brittleness; but as a measure of stiffness and useful strength without distortion, the proportional limit and not the yield point should be employed. That this can be done as readily in non-ferrous work as with steel is the chief conclusion to be drawn from the tests that have been described.

Acknowledgment should be made of the assistance of Austin B. Wilson in making many of these tests; and the author is also indebted to the Titanium Bronze Co. for the test specimens on which the work was done and the extensometer used, and to the Titanium Alloy Manufacturing Co. for the use of the testing machine and other laboratory facilities.

Niagara Falls, N. Y.

Exports of Crude Rubber From Brazil and Peru

The total shipments of crude rubber from the ports of Para, Manaos, and Itacoatiara, Brazil, and Iquitos, Peru, during the month of January, 1920, amounted to 6,273,039 lb., as compared with 6,624,915 lb. in the corresponding month of last year. Shipments from these ports during February totaled 8,162,264 lb. in 1920, as against 9,242,309 lb. in 1919; and the March shipments were 6,916,352 lb. in 1920 and 9,512,787 lb. in 1919. The price of this commodity still continues low and the effect of the low price is seen in the refusal of merchants to place large orders for forward delivery.

New Uses for Stainless Steel

Stainless steel is being employed very largely in the manufacture of pump rods, valve spindles, valves and other parts which are exposed to contact with water, steam and other corrosives. The scientific-instrument trade is using it for drawing instruments and other precision tools and for surgical instruments. It is being manufactured into stair rods, saucepans and pans of varying shapes, fenders for the hearth, and even into pokers and garden implements; and butchers' rails, spikes, skewers, saws and other butcher-shop requirements are being made from it. Sport is also taking an interest in stainless steel and is promoting a demand for golf-club heads, spurs, etc.

Scientific Control of the Filter Station—III

A Discussion on Washing and Drying Filter Cakes—Blowing With Air or Steam to Displace Filtrate, Wash Liquor and Water — Operations Fundamentally Dependent on Cake Formation*

By ARTHUR WRIGHT, M.E.

UNDOUBTEDLY present-day filtration is marked more by the advance in labor-saving devices than by any other feature of modern type filters. More economies, however, have been made in the better washing of the cakes in the new type filters, for whereas residual soluble in the cakes was formerly counted in whole per cents, today it is in fractions of 1 per cent. Materials that needed exacting washes were not handled in filter presses, the wash water in which almost always left some parts of the cake incompletely washed, yet these materials are today handled most efficiently in the modern filters.

The reason for the better results obtained is found in displacement washing. This is the term used to define that wash in which the liquid entrained in the voids of the cakes is pushed ahead of the wash water without the latter mixing with the liquid. In practice it is the simple filtering of the wash water through cakes the surfaces of which are equi-resistant.

All credit is assuredly due George Moore, who first realized the value of an equi-resistant cake and made it the foundation of his patents, both process and apparatus. His discovery was the factor which saved the cyanide process of gold extraction from being a pretty laboratory experiment and made it the forerunner of the efficient systems now employed.

Uniform Resistance to Flow Desired

The explanation for the practical production of an equi-resistant surface is had by reference to Fig. 5. Take any points *A*, *B* and *C* on the cakes, which may have been uniformly built up or may be tapering cakes the bottom of which is thicker than the top. The resistance to the flow is the same at all of them while filtration is taking place. The proof of this is found in assuming that at *A* the resistance is less than at any other point; then, according to the law of the flow of liquids, which seek the path of least resistance, a greater flow must pass through at the point *A*. Since, however, muddy liquor enters the filter and clarified liquid issues from it, the greater flow at *A* creates a greater deposit of the solids of suspension and this obviously increases the resistance to the flow until it is equal to the point *B* or the point *C*. It must, therefore, be acknowledged that during filtration, and at the close of the filtering cycle, the cakes present an equi-resistant surface to the flow of the filtrate.

The advantage of an equi-resistant cake surface must be apparent in obtaining a uniform wash of the cake. When the wash water cannot penetrate any part of the cake faster than any other, it forces the liquid entrained in the voids of the cake through as undiluted filtrate. This, of course, is the end desired, but it must not be thought that all the soluble can be recovered without some dilution even with the best types of filters and with the most expert manipulation. The bulk of the soluble can and should be so regained, but due to capillary attraction and dead end pores of porous material some soluble is retained and lags behind that forced out from the interstices of the cake. This liquid is recoverable by diffusion with the wash water and regained as a sweet water or weak liquor.

These facts are brought out in the graph known as the Washing Curve shown in Fig. 6. This is a plot obtained from periodic readings of the amount of wash filtrate flowing and its density. The abscissæ are the gallons flow and the ordinates the density.

Wash Liquor Displacement of Filtrate

Assuming the density of the filtrate to have been 32 deg. Bé., the curve of the theoretical ideal displacement wash is seen to be a broken straight line and is interpreted as meaning that all of the soluble is recovered at the high density and when all is forced out the density falls to that of the wash water. This is, as explained above, impossible in practical operation and has its value only when serving to note the efficiency of the practical operation.

The leaf-displacement curve is typical of good operation in leaf type or continuous filters. It will be noted that there is a gradual fall from the maximum density before the sharp break occurs. The explanation for this is that the viscosity of high density liquids is greater than that of the wash water or low density liquids. When washing commences the cakes present an equi-resistant surface, but as the wash water penetrates the cake some parts of the cake are made slightly less resistant so that the water flows through somewhat faster at such points. The turn of the curve before reaching zero is the result of the capillary attraction above referred to.

Washing Efficiencies of Plate and Frame Presses

The curve depicting the wash in plate and frame presses is representative of that obtained from alternate plate system of washing. Here the wash water finds channels and quickly weakens the strong effluent, causing a fall in the specific gravity. For the same reason, an effluent of a gravity equal to the wash water is obtained only by using excessive quantities of wash water. The reason for this is quite evident when we comprehend the conditions obtaining. In a plate and frame or chamber filter press initial filtration is analogous to that of leaf type filters and varies from this latter practice only when the cake on adjacent filter cloths in each frame meet. From that point on, the pump, feeding the press, does work not of cake building but cake compressing. This of itself is not a serious drawback, but it is practically impossible to compress all of the cake evenly or completely. It must

*For Parts I and II, see CHEM. & MET. ENG., vol. 22, Nos. 22 and 23, June 2 and 9, 1920, pp. 1,015 and 1,077.

also be remembered that the initial path of the wash water from the alternate plates is in a direction counter to that of the filtrate which produced the cake. This counter-current of the wash water is vital. The resistance of the cake to a counter-current wash is seldom equi-resistant, for it is the exception when the frames are completely and evenly packed. Consequently, it is obvious that paths of less resistance are open to the flow of the wash water and universal practice demonstrates the inadequacy of alternate plate methods of washing filter press cakes.

Plate and frame presses of a sluicing type such as the Merrill Press and automatic discharge type such as the Atkins-Schriver employ the displacement system of washing and have registered marked successes in their washing efficiency. To work ordinary plate and frame presses on this system is to invite nice control if discharging troubles are not to be encountered.

Original Formation of Cakes Must Be Preserved

From the foregoing it is seen that the formation of the cakes must be preserved if true displacement wash is to be obtained in leaf filters. Most materials in plant operation vary from time to time in their filtering characteristics so that in leaf filters it is generally found that there is too much unfiltered material to allow the wash water to be turned on directly at the close of the filtering cycle. To do so would surely mean a dilution of the strong liquor lying in the filter and to increase unduly weak liquor production. Practice, therefore, requires drawing the excess from the filter before the introduction of the water. This method allows materials to be washed at the end of their economical filtering cycle and is equally applicable whether the cakes are thick or thin. This feature of leaf filters is an important one and is in contrast to the operation in plate and frame filters, where the cake must be built up until it fills the frames and filtration ceases when the frames are filled. With raw materials varying in percentage soluble so that the material of suspension varies in amount and character, filtering until the frames are full often entails filtering long after the economical limit is reached.

Skill Required in Operation

Unfortunately this method of washing is successful in direct proportion to the ability of the operator. It is in his power to transfer the unfiltered material and fill with wash water so that the cakes remain in a condition practically as equi-resistant as when finishing filtration or he can defeat the desired ends by failing to maintain the equi-resistant surface. It is positively important that he be instructed not only what valves to operate but should be impressed with what he is trying to effect so that he can visualize the conditions inside of the machine. If he fails to maintain a positive pressure, usually by means of compressed air, some cake will slough off the cloths and surely create a path of less resistance for the passage of the wash water. The same is true if he drains or blows back the excess liquor at too great velocity. Again, if he uses too high air pressure, when holding the cakes on the leaves, he is almost positive to dry the upper part of the cakes in advance of the lower part and will either crack the cake or cool it so that in either case it is conducive to the formation of unequal resistances to the flow of the wash water. Obviously this makes for selective washing. Then, too, if he takes too long time in substituting wash water for the excess unfiltered liquor the conditions are the same as though he used too high air pressure. Experimentation will dictate the best pressure to use and the operator when once realizing what he must safeguard against has no trouble in effecting admirable results.

The Direct Washing Method

When handling materials that run uniformly the filters can be designed so that the space between adjacent cakes at the end of the economical filtering cycle will be minimized. With Sweetland type leaf filters, in which excess space in the filter is small, it is then practical to switch on the wash water simultaneously with the closing of the liquor valve. The excess unfiltered liquor is forced through the cake ahead of the water and the dilution of the strong liquor by the water is negligible. The same is true of Merrill type and Atkins-Shriver type plate and frame presses.

The direct washing method, the name given this system of admitting the wash water without withdrawing the excess unfiltered material, is not only advantageous on the score of simplicity of operation and saving of time but allows the greatest approximation to the true displacement wash. The reason is clear, for there is no possibility of any cake sloughing off the filter cloth, no cracks to be developed by air drying and the equi-resistant condition of the cake is automatically preserved so long as there is a positive pressure maintained in the filter during the transfer from feeding liquor to admitting wash water.

It is interesting to note that the quantity of sweet water or weak liquor produced should approach as an ideal that amount which equals the volume of the voids in the cake. It has been explained wherein capillary and absorptive action require something in excess of

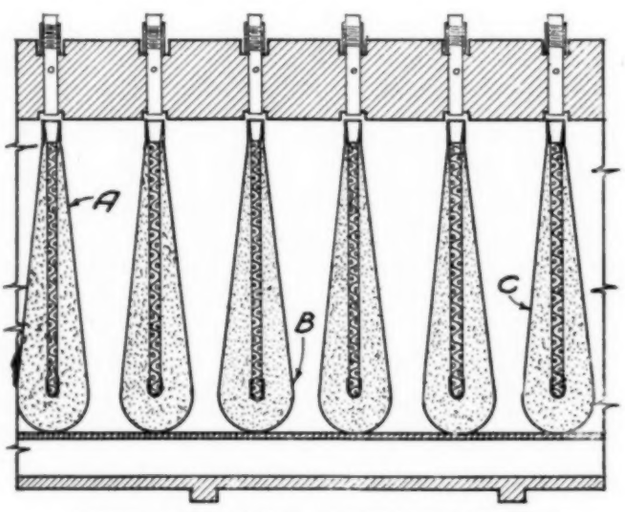


FIG. 5. EQUI-RESISTANT CAKE FORMATION

this in practice, but the actual amount required is oftentimes reduced when the impoverishment of the strong liquor is done by degrees.

By this means the gravity prevailing when fresh water is turned on is much reduced from the original gravity. In practice weak liquor washes are used for this purpose so that all water entering the process leaves it as a strong liquor. The same scheme is worked with marked success in continuous counter-

current decantation installations save that a semi-dewatered solid instead of an equi-resistant surface is subjected to the weak liquor washes.

Spray Wash for Continuous Filter Cake

All of this discussion relative to an equi-resistant surface is equally pertinent to washing the cake in continuous vacuum filters. Here the wash water is applied as an atomized spray, but in theory at least the water sprayed on the cake should, in its passage through the washing arc, envelop the cake and be equivalent to submergence. Excessive amounts of water are unnecessary and will run off the cake. This is, of course, objectionable, but the operator should not go to the other extreme of applying too little water, for then air-drying commences and the wash water will often be short-circuited. It is for this reason that with cakes difficult to wash out the soluble it is advisable to augment the spray wash with a repuddling of the discharged cake with water or weak liquor and filtering and washing on a second machine. This makes for fool-proof and efficient washing especially if the spray wash on the first machine is the effluent from the second machine. Then the strong liquor in the cake of the first machine is recovered at a high gravity.

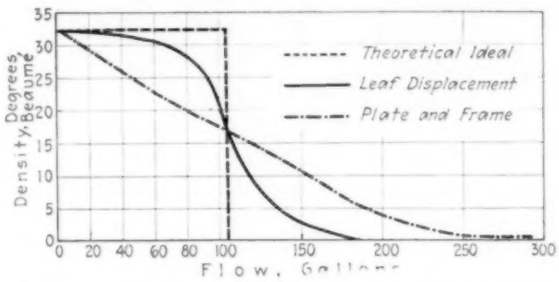


FIG. 6. CHANGE OF DENSITY OF WASH LIQUOR

Advantages of Open Gravity Filters

When handling extremely free-filtering solids such as calcium sulphate from phosphoric, citric, etc., acid manufacture, it is surprising how well the soluble can be extracted in open gravity filters. These filters can usually be home-made machines with false bottoms covered with cocoa matting, burlap, etc., or with the old cinder bed bottom. The one essential point is that the liquor and the wash water must drain by gravity so that the cake is built up uniformly. The cake formed is granular and allows considerable flow per unit surface, but the percolation of the wash water is slow enough so that shortly after the heavy liquid in the voids of the cake is displaced the remaining soluble has had time to diffuse through the wash water. This accounts for the admirable wash obtained in this class of filters, which obviously is confined only to those materials of an extremely free-filtering character. New means of discharge of the cake from this type filters will be described in the article under "Discharging" appearing in a later issue, wherein the manual labor hitherto entailed with this type of machine is obviated.

Drying the Cakes

Drying the cakes is a part of the operation of industrial filters often definitely required but too often thought unnecessary. Dryness of discharge is obviously advantageous when a further drying operation is required. When recovering the soluble from the cakes, oftentimes the cake is a waste product and the percentage of moisture in the cake is not a vital consideration save as a safeguard against high losses of soluble in the discharge cake. If the washing operation has been efficient, drying the cake is superfluous, but if defective washing has taken place, then decreasing the moisture content decreases the soluble in the cake.

Drying the cake is fundamentally dependent on the formation of the cake. If a compact cake is produced, the voids in the cake are minimized; if a fluffy cake is formed, the percentage of voids is large. In either case the work of drying the solids is the removal of the liquid in the voids. Obviously those cakes having low percentage voids require less duty on the drying operation than those with high void content.

Advantages of Recessed Plate Filter Presses

Plate and frame or recessed plate filter presses stand in a class by themselves as filters delivering dry cakes. The reason for this is explained in that the cakes are more compact than those obtained from any other type filter. The initial filtration in filter presses is identical with that in leaf or continuous filters except when filtration has progressed so that the cakes on adjacent filter cloths meet; then the filtration in filter presses varies from the filtration in modern type filters in that the pump begins to do work of cake compression rather than continuing that of cake forming. It is this cake-compressing action that helps so materially in the production of cakes of low voidage.

With the above in mind it is therefore evident that there is a definite width of frame for each material in order that efficient operation of the filters and the discharge of the driest cakes be obtained. Too wide a frame requires too long a cake-building period and allows too great a resistance to the flow to be set up before the work of cake compression commences. It is thus seen that for any particular material there is a balance between the maximum caking capacity of a press and the dryness of the cake, consistent with efficient operation. In the writer's experience these data are best determined by experimentation on a single leaf filter when the filtering characteristics of the material are determined without giving thought to dryness of discharge.

The principle of cake compression for dryness of discharge is unfortunately not applicable to leaf type filters. Here the cakes must not be allowed to form so as to touch each other or otherwise all the advantages of displacement washing and self-discharge are jeopardized. Also overcharging in pressure leaf filters is insidious in its evil effect of warping the filter leaves. The difficulty from tearing the cloths on distorted leaves and from straightening the drainage members is apparent, but in a well-designed and well-operated machine the filter leaves are spaced so that the cakes do not meet. When the leaves are bent out of shape it is practically an impossibility to straighten them completely, at least while in the filter, so that the original spacing is changed and some of the leaves are on closer centers. This, of course, is a condition ripe for continuing this difficulty and becomes a constant source of trouble. It is not generally understood just what produces the distortion of filter leaves. It is not that the leaves bend away from the cakes which have joined together but that by their having joined together the pressure between them is lowered while the exposed

sides of the leaves are subject to the full pressure. This gives an excess force which, acting over the entire surface, exerts enough pressure to cause the leaves to bend in toward the joined cakes.

Moisture Displacement by Compressed Air

Drying the cakes in leaf type filters, therefore, must be obtained by displacing the entrained liquid in the voids of the cakes by some gas (compressed air, steam, etc.). This part of the filtering cycle is undoubtedly the weakest in the operation of leaf filters. To start with, the cakes, as built up, are high in percentage voids, a mere examination of the cake showing the exterior of the cake to be far wetter than that against the filter cloth, and the bulk of the liquid extracted from the cakes must pass through an ever-increasing resistance until penetrating the filter cloth. This, of course, entails a high duty on the drying agent.

When drying with compressed air, which is in reality filtering compressed air through the cakes, the effect is to supplant the liquid in the voids of the cake with air. This obviously is less support for the particles of the cake, so that there is a rearrangement of the particles—generally spoken of as the "shrinking of the cake." This shrinking results in cracks developing which immediately form paths of less resistance for the passage of the compressed air. At this stage the drying effect is negligible in comparison with the work of compressing the air and best practice is to halt the drying operation at this point.

Prevention of Cracking of Cake

Best drying operation in leaf type and continuous vacuum filters is obtained, therefore, by proceeding in that manner which decreases the early formation of cracks. With granular and similar materials this is so practical that the difference of percentage moisture in cakes of such materials as discharged from modern filters and moisture in cakes as discharged from filter presses is not large. When handling fine, flocculent materials it is more difficult to prevent early cracking. The procedure in such cases is to build up as dense a cake as possible before admitting the compressed air and to remove as much moisture in the cake at as low a pressure as possible. The means of forming the dense cake can best be determined by experimentation, but it is often found that if the initial filtration be carried on at a low pressure and allowed to rise to a point considerably less than that used during the washing operation, good results are obtained. In vacuum continuous filters, especially those of the drum type, flapping and cake-compacting mechanisms can effect this result mechanically. In any design of vacuum continuous filters where cake cracking cannot be avoided there is a big saving on the duty of the vacuum pump if the automatic valve be constructed so as to shut off the suction at the time of crack formation.

Leaf type filters constructed so that the outlet of the leaves is at the top of the leaf are not as satisfactory as those that drain from the bottom. The reason for this is quite apparent, for bottom-discharge leaves drain out all the liquid, whereas the top discharge pockets the liquid and on discharge that liquid is forced back through the cloth and mixes with the discharge cake. This is the advantage of bottom-drainage filter leaves and is the only reason for drier cakes being obtained from their use.

It is a proved fact that many materials may be discharged from leaf or continuous type filters higher in percentage moisture than cakes of the same materials discharged from filter presses and yet in subsequent driers will be found to work better. This is due to the cake formation admitting a better heat conductivity and escape of the steam vapor. True, if the cake from the filter presses be broken up, then the advantage lies with the filter press cakes.

Firmness of Cake

It is somewhat academic but nevertheless important to understand clearly the theory of cake formation, which bears such a relation to drying efficiency. When a filter is first started up or when a section of a continuous filter first dips into the liquor the rate of flow is the greatest. The flow may quite as readily be conceived as the summation of the delivery from every square inch of surface. On each unit area, cake is being deposited and its compactness is in direct proportion to the velocity of the liquid being filtered. When the velocity is high the stream lines are said to be strong, and weak when the velocity is low. Therefore, if the velocity be maintained at a high rate for a long period, the stream lines are strong and the cake firm. This then gives the reasoning on which better drying effect is obtained when starting with low pressure for the handling of difficult filtering materials because this low initial pressure does not build as resistant a cake and admits of a greater flow throughout the cycle thereby. Obviously the cake produced by strong stream lines must be a dense cake if we consider the cake as being built up by arresting the particle of suspension carried by the stream lines (its momentum being in direct proportion to the velocity of the stream line). The greater the momentum the greater the impact upon the cake and the denser the cake produced.

(Part IV, dealing with Discharging, will be published in a subsequent issue.)

Hongkong's Imports of Chemicals

The trade in chemicals at Hongkong in 1919 showed little life and very little increase over that of 1918. The total value of the trade is given by Hongkong official statistics at $2,572,755, compared with a value of $2,265,582 in 1918.

The chief items in the trade were saltpeter, which reached a value of $459,659 and came almost entirely from India; camphor, valued at $288,935, supplied mainly by north and middle China and Japan; soda ash, $228,342, almost entirely from Great Britain; caustic soda, $194,696, of which two-thirds came from the United States and most of the rest from Great Britain; and the usual run of miscellaneous drugs and chemicals, none of which reached $100,000 in value. There was a marked decrease in the imports of acids, most of which came from Japan, and also smaller imports of bleaching powder (in quantity, though the value stayed about the same for the two years), calcium carbide, phosphorus and glycerine. There were increased imports of alum, borax, quinine, chlorate of potash and sulphur.

In a general way Hongkong importers found it difficult to secure supplies from the United States and most of them returned to their old British connections as rapidly as conditions permitted. Present exchange conditions militate against local industries, and this is reflected in the lessened demand for chemicals.

Extraction of Tannin From Indian Myrabolans

THE following note on myrabolans (myrobalans), the fruit of *Terminalia chebula*, prepared by the tannin expert of the Government of India, appeared in a recent issue of the *Indian Trade Journal:*

The myrabolan fruit—or, as it is often incorrectly called, the "nut"—is usually collected when still green. After collection it should be promptly dried in the sun. The best grades of myrabolans, viz., the Bhimlis and Jubbulpores, are collected in this way. Bombay nuts are riper when collected and are apt to be somewhat soft, waxy and spongy. They have a smoother skin with larger wrinkles than Jubbulpores and Bhimlis, and are, as a rule, less liked by the trade, but have been reported to be actually richer in tannin than the harder, shriveled, first-grade nuts.

In Europe myrabolans are the best-known Indian tanstuff, and find a very wide application in mixture tannages. In India myrabolans are largely used in mixture tannage, and perhaps still more largely as a "bleaching" agent at the end of the tanning process. This is especially in the case in the tannage of the "crust" leathers of Bombay and Madras with avaram or turwad (*Cassia auriculata*), when the tannage is completed by a bleaching process in a brew of myrabolans. For this purpose, myrabolan extract would not be suitable, but in mixture tannages extract could be utilized to replace the myrabolans at present used. For tannery use myrabolans should be crushed before extracting the liquors.

Myrabolans have also long been known as a dyestuff. They are, for instance, used in Bombay for the production of yellowish-buff shades on cotton. Myrabolans also find some application in the manufacture of inks, which are produced by the addition of iron salts, suitable gum, and some "soluble blue" dye. In Europe, myrabolans are used in the dyehouse for the mordanting of cotton as a preparation for the application of basic dyes, the weighting of black silk, etc.

Nuts for Export

Spongy nuts, which do not keep so well as shriveled nuts, might be used for the preparation of a "No. 1 crushed" myrabolan product. For this, the nuts would be crushed with a wooden mallet as soon as collected, and the comparatively valueless stones removed. The remaining flesh should be dried in the sun, when, if the nuts were in sound condition when crushed, the product should show approximately some 50 per cent tannin.

From the economic standpoint it would really be better to crush all myrabolans intended for export abroad and to dry the flesh in the sun. Removing the useless stones would effect considerable economy in freight while enhancing the proportion of the valuable tannin constituent in the product exported. There is, however, a prejudice on the part of the European public against crushed myrabolans, because, when exported in this finely divided form, the addition of adulterants is easy to effect and difficult to detect. Crushed myrabolans, therefore, could only be exported where an absolute and unimpeachable guaranty of genuine purity could be given and the quality always maintained over a long period. On the other hand, whole nuts cannot well be adulterated, and if of good grade will always secure their prices, even when sold by an unknown vendor. They should contain 30 to 40 per cent tannin.

The percentage of tannin in a solid extract should approach very nearly to 60 per cent. The gain in concentration over the best whole nuts is therefore very considerable, although much less so in the case of the pure crushed product without stones.

Advantage of Extract Over Raw Product

Although a solid myrabolan extract is not much richer in tannin than the crushed stoneless product, it consists, in the main, of soluble matters plus water, whereas the crushed raw product contains vegetable fibrous matter which adheres to fabrics in the dyehouse and also to the leather in the tanyard. In the latter case, however, it is not a very serious objection, and in the case of bleaching with myrabolans the product crushed is in its most effective form for the purpose; but crushed myrabolans could not be used to strengthen tan liquors materially, as the tannin principle is dissolved from it relatively slowly, whereas solid myrabolan extract is readily soluble.

Myrabolans will produce a very good paste extract of, say, 40 or 50 deg. Tw. The solid extract, also, has long been a commercial product. It is, however, inclined in moist, warm weather to become soft and sticky, at least on the surface of the block; this owing to the affinity for water of certain of the non-tannin constituents in the extract. Their presence makes it doubtful whether it would be advisable to prepare the myrabolan extract in crystal form except for use in cold countries. In hot, moist climates such crystals would be likely to re-cohere into a solid mass, though it is possible that this difficulty may be overcome in the course of time. Apart from this hygroscopic tendency, myrabolans produce a good, clear extract which is fairly free from insolubles and has good keeping qualities. The extract is readily soluble in water, but dilute solutions very soon deposit "bloom" or ellagic acid. It is the loss of some of this "bloom" during concentration to solid extract that renders the extract less suitable than the raw material for the so-called "bleaching" process.

Process of Manufacture of Extract

The process of manufacturing the extract may be divided into three sections—(*a*) crushing, (*b*) leaching or extracting, and (*c*) conversion of relatively weak leach or extractor liquors into extract.

(*a*) Suitable machines are available for crushing the myrabolans in such a way that the useless stones drop out. The tannin principle of myrabolans is so inclosed in the cells that it is not very easy completely to extract the raw material, and it is for this reason that figures of yield nearly approaching the theoretical possible are so seldom attained.

(*b*) For the best extracting or leaching, series of connected leaches or extractor pits or vats are required. Water passes first over all but exhausted raw material and then into a series of pits over less and less exhausted material, until in the final pit, before it is drawn off, it passes over absolutely fresh material, this pit being regarded at the moment as the head of the series. The pit, however, over which pure water had been passed to extract the last traces, is now emptied and filled up with fresh raw material, and in its turn becomes the head of the series, the pits always being worked in a circular rotation.

(*c*) The liquors from leaches are allowed to settle in a suitable pit, or in some instances are subjected to

filtration at this stage. The clear liquors are then drawn by vacuum into a multiple-effect vacuum evaporating system in which they are rapidly concentrated (in a few hours at most) to a liquor of say, 50 per cent solids strength. The liquors are then pumped, or drawn by vacuum, into a finishing evaporator which is usually of the Calandria type. Here the thick liquors are further concentrated during several hours to a paste, which will just flow from the pan while still hot. The extract in this form is collected in paper-lined boxes, and in the course of a night will set to solid. When properly prepared, myrabolan extract should be readily soluble in water, giving an amber to amber-brown solution. The solid extract should have a clear, bright, vitreous fracture.

If myrabolan liquors are concentrated to solid in the air, much decomposition of the tannin ensues; the extract is black in color and contains objectionable tarry decomposition products.

The Alsatian Petroleum Industry

During the present time of fuel shortage the petroleum wells at Pechelbronn, in Alsace, have taken on a new importance. These wells are of considerable value. They were first discovered in 1735; a few years later a small refining plant was constructed, and the wells have been worked for about 180 years. They are among the oldest petroleum wells in the world. In 1888 underground digging was replaced by the modern boring method; but during the war the older method had to be resumed, and shafts were driven to a depth of 275 yd. These petroleum deposits are now the only ones in the world worked by shafts. This method of exploitation is made difficult by the fact that the beds of sand under the earth become impregnated with inflammable gases and a slight accident will cause a serious explosion. Two thousand workmen are now engaged at Pechelbronn in various kinds of work, including the location of new deposits of oil, the extraction of the crude oil, distilling, refining, etc. Pechelbronn produces 50,000 tons of petroleum products per year.

MODERN EQUIPMENT—NEW DEPOSIT RECENTLY TAPPED

All branches of this flourishing plant are equipped with the best modern machinery. The drilling machines, of which there are forty-four, are run by electricity or steam and are distributed over a surface of 110,000 acres. A network of electric wires, over 42 km. (26 miles) in length, furnish power to about 500 oil pumps. Three shafts, with 4,000 m. (13,000 ft.) of subterranean galleries, produce more than 25,000 tons of crude petroleum per year.

Recently a drill driven to a depth of 435 m. (1,427 ft.) in a region hitherto untouched located a new deposit, and the well is now spouting petroleum at the rate of fifty tons a day. New refineries are to be installed capable of distilling 73,000 tons of crude petroleum per year. The distillation is to be by the "continuous" process, with perfect vacuum.

These Pechelbronn petroleum deposits are of great value to France at the present time, not only because of the fuel which they yield but because of the information which French capitalists are able to obtain from them as to the best method of handling petroleum deposits in which they are interested or have concessions in foreign countries.

Legal Notes

BY WELLINGTON GUSTIN

Rodman Patent for Method of Making Case-Hardening Material Held Valid

The Rodman patent, No. 1,076,453, for a method of making case-hardening material, has been held valid and infringed by the United States Circuit Court of Appeals, Seventh Circuit, reversing the District Court. Suit for infringement of the patent was instituted by the Rodman Chemical Co. against the Deeds Commercial Laboratories. The invention relates to improved methods of manufacturing carbonizing material for dry packing. The product of this process is small masses or pebbles of carbonizing material, made out of what was theretofore largely waste dust. The advantage over other carbonizing products was its reduced costs, due to the utilization of a waste product, its greater thermal conductivity, easier handling over powdered or dusty carbonizing materials, and especially its retention of identity under heat.

The claims of the Rodman patent in the suit were Nos. 1, 7, 10, 17, 22, and 25. Claim 1 follows:

"1. The method of adapting finely divided material for use as carbonizing material, which consists in mixing the material with a binding agent and forming small masses which will maintain their identities when heated."

Claim 22 differs only in describing the binding agent as "tacky" and claim 25 by adding after the words "binding agent" the phrase "such as molasses." In claim 7, the method of forming "small rounded pebbles," instead of "small masses," is stated as "tumbling to form." Claim 17 reads:

"17. The method of preparing carbonizing material which consists in fashioning finely divided material into substantially smooth-surfaced pebbles and in then applying heat thereto."

The Deeds Commercial Laboratories defended the suit, claiming that the process had been used for more than two years prior to application for patent. Another defense was that the process had been anticipated and was invalid for lack of invention, while still another was non-infringement. The District Court for Indiana found for the defendant on these grounds, but this judgment was reversed on appeal.

CLAIMS OF PRIOR USE DENIED BY COURT

On the question of prior use it was found that the Rodman Chemical Co. manufactured successively and contemporaneously several kinds of carbonizing materials; and that the product from the method of the patent under suit was the final and most successful one. This differed in substance, in form and in quality from the others, each marking an advancing step in the manufacture of a valuable commercial product, yet each produced by a definitely distinct method. Proof showed that the method of the patent was not used prior to 1912, and the patent was granted Oct. 21, 1913.

On the question of infringement the court said there was infringement, except as to claim 7, if the claims are to be broadly interpreted. The defendant used charred carbonaceous materials in powdered form and

a solution of molasses and water; they are mixed in a mixing machine, small balls or pills being produced. The proper sized ones are first air-dried, and are then dried in a revolving drum with heat applied. The purpose of this final heating was alleged to dry out the excess moisture, yet the effect thereof in this revolving drum is to reduce the size of the pills and to compact and harden them. Whether this be technically a "tumbling" operation or not, it is the equivalent thereof; the sole purpose of tumbling is to compact or harden the pill; and whether this be accomplished in one operation, during their formation as pills, or in two, is immaterial. In his claims Rodman is not confined to the use of such carbonaceous material as requires coking, and the court said that defendant's use of coked or charred powder as against Rodman's preferential method of using coking coal dust does not therefore avoid infringement.

While some carbonaceous materials, like charred leather, require no special preparation, others, like charcoal, coke, or coal, require, for commercial use at any practicable temperature, the addition of a chemical energizer, such as lime, in order to activate the carbon. But the patent is not limited to the use of a carbonaceous material requiring the addition of an energizer. The carbonizing material in each of the claims covers as well carbonaceous materials, such as charred leather or corncobs used by defendant, having in themselves sufficient energy to activate the carbon.

Court Discusses Case Hardening

On the question of anticipation and want of invention in the patent, the court discussed case hardening as presented to it. Case hardening is a species of carbonizing. If it be desired to harden the metal throughout, carbon is dissolved into the molten metal. If, however, only the surface is to be hardened, so-called case hardening, the finished product is packed in dry carbonizing material; the box is sealed and placed in a red hot furnace for several hours; the carbon gases produced are absorbed only by the surface of the metal. When the required depth of carbonization is secured, the article is dropped, red hot, into cold water; this makes the carbon skin or "case" perfectly hard. The interior of the article, not having been carbonized, remains soft and tough. The desirable and sought-after product for case hardening was one that would be susceptible of repeated use; the small pill, maintaining its identity when heated, answered this need. The uniform distribution of carbon and energizer, resulting from their use in powdered form, and the maintenance of this relation by the permanent binding together of the particles, as well as the freedom from dust, were additional advantages of this pill or pellet formation. Moreover, a waste material, the coal or coke dust, heretofore discarded was utilized.

A new product was thus created; a product of commercial value for definite uses, said the court. Earlier patents, Dodds, British, No. 571; Aube, British, No. 738; Demenge, No. 564,053; Logan, German, No. 181,-531; all of which mention incidentally case hardening, and Meyer, No. 524,904, while referring to the use of carbonizing briquets made of powdered materials or of balls of carbonizing paste, give no hint that these products will not be completely absorbed in a single carbonizing process, or that they will maintain their identity under heat; nothing whatever is said in any of them as to the method of manufacture. The court said they were different products than those made under the process of the patent in suit.

While each step in the process of making these pellets may be old as applied to other articles, the conception of this novel product and of the combination of acts necessary to produce it is novel, said the court. In the light of the present knowledge, it may have been a simple matter for defendant's expert, from a reading of the earlier patents, to create a product identical with that of the process in suit and by the same means; this, however, is no demonstration that the product or method would have been obvious to one skilled in the art but ignorant of the patent in suit.

Rodman's essential contribution to the art through the patent was the step by which the identity of the small pellets was maintained, and their continued use in actual practice for about 500 hours made possible. And the court held that defendant made a substantially identical product by a substantially identical method, resulting in infringement.

Uses of Duralumin in Aëronautics

The National Advisory Committee for Aëronautics at its recent semi-annual meeting acted favorably upon the recommendation of the committee on materials for aircraft and adopted the following resolution:

> *Resolved*, That the executive committee be instructed to communicate with various manufacturing companies, inviting their attention to the importance of duralumin products, especially tubing, for airplane wings, and endeavoring to secure their co-operation in the development of duralumin products for airplanes.

It is considered to be a highly essential matter that duralumin and similar wrought aluminum alloys, as well as aluminum castings alloys, be made available for military use. It is also anticipated by the metallurgical experts that a large commercial future can be expected for these materials, not only in commercial exploitation of airplanes, but also in automotive construction and in other industrial work where strong, light alloys are much needed.

Metal parts of Zeppelins were made of aluminum alloys and the later ships were all of duralumin. In the United States a considerable amount of duralumin metal has been produced in simple shapes, while in England, France and Germany the production has been carried to almost all conceivable wrought shapes. For example, Fokker all-metal planes have duralumin wing coverings replacing fabric, duralumin frame-work in various welded and formed shapes and duralumin tubing for the supporting members.

German Potash Situation

In the *Times Trade Supplement* (London) of April 10, 1920, the following interesting article on the German potash situation was published:

"At a general meeting last month of one of the most important concerns in the German potash combine it was reported that the present position of the German potash industry is very unhealthy. Exports in 1919 were 3,000,000 metric hundredweight, as against a pre-war exportation of 12,000,000 to 16,000,000. The home supply was actually worse in 1919 than in the previous year, falling from 16,000,000 to 12,000,000, whereas before the war about 24,000,000 metric hundredweight was furnished. Of the 200 potash works in the combine 80 were shut down entirely last year. It is noted that the individual output of the workers fell from 149 tons in 1918 to 65 tons in 1919."

Vulcanized Fiber

By L. R. W. Allison

The increasing popularity and utility of vulcanized fiber for electrical, mechanical and other purposes lends particular interest to this material and its composition. Up to the present time but brief information has been published on the subject, indicating that a broadened knowledge will prove decidedly advantageous in various channels of operation.*

Vulcanized fiber has assumed an important status in the manufacture of parts, tubing, rods, bushings, washers and disks, etc., replacing die-stampings and other metal productions for numerous specialties. Its use is not only becoming standardized, but phases of manufacture are being improved to that degree to insure absolute certainty as to service and life.

The industry as a whole has grown to a noticeable extent during the past few years, and leading manufacturers, not content with immediate accomplishments, have been studying further possibilities.

How Vulcanized Fiber Is Made

Vulcanized fiber is manufactured from cotton rag stock, which, after being cut into small pieces, is boiled with soda, washed, bleached and beaten to a pulp; it is colored red or black, or left in its natural gray state, and then run off on paper machines, which convert it into a high-grade cellulose paper, both unsized and unadulterated. The paper subsequently is passed through a bath of zinc chloride in which its surface is gelatinized to such an extent that, on being "built up," the various layers become as one homogeneous sheet of any thickness desired.

These sheets are in turn treated to remove and neutralize the chemical reagents, after which they are dried and calendered, then cured or seasoned for a period varying up to one year, according to the thickness. The importance of natural aging or seasoning will be appreciated when it is understood that any attempt to force this process, for the purpose of cheapening the product, invariably results in an inferior material. In such event, the ultimate life of the fiber is lost or shortened and its dielectric strength impaired.

Properly prepared vulcanized fiber, because of its toughness, elasticity and durability, is superior to hard rubber and porcelain for electrical or mechanical purposes. In its finished form it does not shrink, warp, twist or expand unless exposed to moisture; and when used in moist places, gives satisfactory service if coated with shellac or other moisture-excluding compound.

Fiber Tubing and Fiber Rods

Fiber tube has become an important material in electrical insulation, due to its properties and the ease with which it may be made into any desired shape. This tubing is prepared in the manner explained above. The paper is gelatinized and run on steel mandrels of a size which determines the inside diameter, while the number of turns establishes the wall thickness, or the outside dimension. In the electrical industry, fiber tubes are being used very generally for flashlight cases, cable conductors on automobiles, vacuum-cleaner nozzles, and the like.

Fiber rods are made from sheet fiber. The sheet is cut into square bars and then run through a rod or dowel machine. Accurate diameters are obtained to 2 in., with 5 ft. as the standard length. This rod may be used for the same purposes as metal rod and for any special parts usually made from metal, such as bushings, screws, push buttons, and so on.

Fiber can be machined very easily and accurately, and into practically any shape. It can be embossed with equal facility and takes a very fine finish.

Standard Sizes Manufactured

Standard sheets of vulcanized fiber as produced by the Mitchell-Rand Manufacturing Co., New York, come in a size of 44 x 72 in. The thickness varies from 0.005 in., weighing approximately 0.8 lb. per sheet, to 1 in., which weighs about 160 lb. per sheet.

Fiber tubing is manufactured with an inside diameter varying from $\frac{1}{8}$ in. to 6 in., and with thickness of wall in $\frac{1}{32}$-in. variations, from $\frac{1}{16}$ in. to $\frac{3}{4}$ in. Up to 1 in., the inside diameter increases by $\frac{1}{16}$-in. measurements, and above this diameter by $\frac{1}{8}$-in. variations. The lengths vary from 2 to 3 ft.

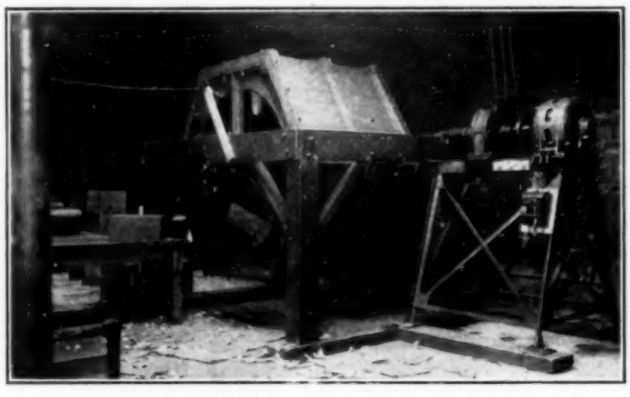
Newark, N. J.

*A concise statement of the manufacture and properties of vulcanized fiber, by Charles Almy, Jr., appeared in Metallurgcal & Chemical Engineering, vol. 13, p. 746 (Oct. 15, 1915).

Drum Tester

In a test for strength of shipping boxes, the object of which is a simulation of the rough knocks, bumps and jars of handling which a loaded box may encounter in railroad traffic, there has been designed a machine by which the railroad usage which a box may meet in a 2,000-mile haul can be duplicated in four or five minutes.

The first machine of this kind—known as the drum box-testing machine—was designed by the U. S. Government Forest Products Laboratory at Madison, Wis.



DRUM BOX-TESTING MACHINE

The machine installed at the Mellon Institute is an improvement over the original tester in that the inconvenience of overhead pulleys and shafting has been done away with by the substitution of a reduction gear for cutting down the motor speed to the drum speed of 2 r.p.m.

A valuable field of investigation and scientific study of the construction and materials of packages is opened up by the new machine, such as best methods of interior and exterior packing for fragile or irregular shaped objects; the determination of proper specifications for containers carrying various commodities, etc.

The Container Club of Chicago, an association composed of corrugated and solid fiber box manufacturers of the United States, offers free service in the designing of scientific packing methods for the various commodities capable of being shipped in fiber containers.

Recent Chemical & Metallurgical Patents

Toluene From Xylene.—To the fraction of solvent naphtha which is obtained between 135 and 145 deg. C. and which consists principally of metaxylene, is added 5 to 10 per cent of anhydrous aluminum chloride. The latter combines with a portion of the xylene to form the active catalyst, which is a reddish liquid not miscible with the hydrocarbons. Upon distilling this mixture under suitably regulated conditions, the toluene is removed as rapidly as formed. Plugging of the column and condensers due to volatilized aluminum chloride is avoided by distilling under a 14 in. vacuum. (1,334,033 and 1,337,317; ARTHUR E. HOULEHAN of Wilmington, Del., assignor to E. I. du Pont de Nemours & Co.; March 16, 1920 and April 20, 1920.)

Continuous Electrical Mechanical Filter.—For removing colloidal and other fine suspensions from liquids, ARCHIBALD F. MESTON, of New York, has devised a continuous filter in which the colloidal particles are agglomerated prior to filtration by electrostatic action. The revolving drum forms one electrode. The other electrode is hollow so that the liquid to be filtered may be fed in through it. Difference of potential is maintained by current from the secondary winding of a transformer. (1,334,160; assigned to Research Corporation; March 16, 1920.)

Metallic Sodium.—Many of the difficulties encountered in the Castner process for the production of metallic sodium by the electrolysis of fused NaOH are overcome in the process devised by ALBERT W. SMITH and WILLIAM R. VEAZEY, of Cleveland. The electrolysis of a mixture of 35.6 parts of sodium chloride and 64.4 parts of sodium carbonate yields metallic sodium equal in quality to the present commercial product. This mixture melts at 600 deg. C. (1,334,179; assigned to the Dow Chemical Co.; March 16, 1920.)

Sulphuric Acid Plant Construction. — It has been customary to support the lead curtain walls and tops of sulphuric acid towers and chambers by means of independent wood or steel structures, whether or not such towers or chambers contained interior masonry walls or packing. These methods have involved heavy and expensive framing especially in those cases where it was desirable to use towers or chambers of considerable height. ELDON L. LARISON, of Anaconda, Mont., proposes to construct towers or chambers of this type in such a way that the lead sheathing of sides and tops with the necessary light framing to which the supporting lead straps are attached shall be supported on the masonry walls. Construction details are given. (1,334,384; March 23, 1920.)

Adsorption of Vapors and Gases by Silica Gel.—Silica gel is an efficient adsorbent for many gases and vapors. During adsorption, the evidence seems to indicate that under certain conditions the gas is actually liquefied in the pores. This effect is obtained under conditions of temperature and pressure widely different from those under which ordinary liquefaction takes place. Thus 100 to 200 atmospheres pressure is required at 0 deg. C. to liquefy the SO_2 out of air containing 1 per cent SO_2. On the other hand, air containing 0.5 per cent SO_2 may be passed through 20 g. of silica gel at 0 deg. C. at the rate of 400 c.c. per minute for two or three hours before the exit gases will show more than a trace of SO_2.

The adsorbed SO_2 may be recovered by passing a slow stream of air through the gel at a higher temperature. By proper regulation of temperature, pressure and rate at which air is admitted during liberation of the adsorbed SO_2, any desired mixture up to practically 100 per cent SO_2 may be obtained. Several drawings of apparatus for the recovery of sulphur dioxide evolved during metallurgical operations are given in the patent specification.

For a brief review of the theory of the adsorption of vapors by silica gel, see CHEMICAL & METALLURGICAL ENGINEERING, vol. 22, p. 949, May 19, 1920. (1,335,348; WALTER A. PATRICK, BENJAMIN F. LOVELACE and ERNEST B. MILLER, of Baltimore, Md.; March 30, 1920.)

Use of Sludge Acid in the Manufacture of Hydrochloric Acid.—A mixture of equal parts of sludge acid and sodium chloride is diluted with 10 per cent of water and heated to not more than 284 deg. C. in a still composed of a lead-lined pan covered by an acid-proof tile arch. The addition of water causes the asphalt and tarry matter to be liberated and to rise to the surface of the solution, so that loss of sulphuric acid through reduction by the carbon in these materials is avoided. The hydrochloric acid gas given off during the heating is purified by passing through towers containing sodium chloride. For the purpose of absorbing the gas in water, the inventor, HENRY M. LASHER, of Kansas City, Kan., describes three types of apparatus: a closed tank into which the gas is passed through a perforated coil; a horizontal absorber in which the flow of gas and water is concurrent; a horizontal counter-current absorber. (1,335,743, 1,337,141, and 1,339,519; assigned to Kansas City Refining Co.; April 6, April 13, and May 11, 1920.)

Magnesium Chloride.—A process for the recovery of magnesium chloride from Michigan brines containing, in addition, calcium chloride and sodium chloride, was described by EDWIN O. BARSTOW in U. S. P. 1,209,245 issued Dec. 19, 1916. It was based upon the reaction:

$$CaCl_2 + MgSO_4 = CaSO_4 + MgCl_2$$

An improvement in this method has been devised by HERBERT H. DOW and EDWIN O. BARSTOW, of Midland, Mich. The calcium is removed from the brine by treatment with sodium sulphite obtained as a byproduct in the manufacture of phenol. Since such Na_2SO_3 contains some carbonate, two reactions occur:

$$CaCl_2 + Na_2SO_3 = CaSO_3 + 2NaCl$$
$$CaCl_2 + Na_2CO_3 = CaCO_3 + 2NaCl$$

After filtering off the insoluble $CaSO_3$ and $CaCO_3$, the solution contains $MgCl_2$ and NaCl. By evaporating to 34 deg Bé. the NaCl separates out. The mother liquor is further evaporated until it corresponds in composition to $MgCl_2\ 6H_2O$, when it is drawn off into drums and allowed to cool and solidify. (1,336,425; assigned to Dow Chemical Co.; April 13, 1920.)

Nitric Acid From Ammonia.—In order to avoid the use of large and expensive absorption towers for the conversion of nitric oxide into nitric acid, ELIHU

THOMSON, of Lynn, Mass., proposes to absorb the nitric oxide produced by the oxidation of ammonia in nitric acid of 60 to 70 per cent strength cooled to —40 deg. C. by the evaporation of liquid ammonia. The solution is then passed to an electrolytic cell in which the nitric oxide and nitrous acid are oxidized to nitric acid. (1,337,106; assigned to General Electric Co.; April 13, 1920.)

Acetates From Carbohydrates.—Carbohydrate material is treated with caustic soda solution to give a mixture having a specific gravity of about 1.4. To the hot causticized solution is added 40 to 50 per cent by weight of powdered quicklime. Slaking occurs with consequent evolution of heat which drives off considerable quantities of water. The product, consisting of damp porous lumps, is heated in a sealed container at 250 to 300 deg. C. for five or six hours. After cooling, the acetates may be extracted by leaching or the mass may be distilled to produce acetone. When corn glucose is treated in this manner, the product is found to contain about 15 per cent of acetates. (1,338,040; JAMES W. H. RANDALL, of Western Port, Md., assignor to Industrial Chemical Co.; April 27, 1920.)

Chlorine Liquefaction.—Chlorine gas may be liquefied at atmospheric pressure by refrigeration to approximately —35 deg. C. or at normal atmospheric temperatures by compression to several atmospheres. A compromise between the two methods appears to be the usual method of liquefaction, the chlorine being compressed about 2.23 atmospheres and refrigerated to approximately —15 deg. C. Heretofore it has been the general practice to secure the compression of the chlorine by means of gas pumps. These pumps are necessarily of very special construction and require high maintenance. CLARK T. HENDERSON, of Milwaukee, Wis., proposes to eliminate the compressor by taking advantage of the fact that chlorine is very soluble in cold carbon tetrachloride. Upon heating the solution, chlorine is evolved and in a confined space sufficient pressure is generated to liquefy the gas. Carbon tetrachloride will dissolve, at —15 deg. C., approximately 122 volumes of chlorine at atmospheric pressure and will give up approximately 100 volumes of this chlorine when heated to approximately 100 deg. C., even though the solution be under a pressure of 45 lb. per sq.in. Carbon tetrachloride is not a good solvent for carbon dioxide, air or hydrogen, the usual diluents of commercial chlorine, nor is it miscible with water, and, at any pressures within the desired working limits for chlorine liquefaction, the boiling point of carbon tetrachloride is materially higher than the temperature at which the chlorine gas is driven off. A detailed description of a continuous apparatus for applying the process indicates some of the precautions which must be taken to insure efficient heat transfer. (1,338,654; assigned to Niagara Smelting Corporation; April 27, 1920.)

Separating Wood Tars and Pyroligneous Acid.—It is the accepted practice in practically all of the wood distillation plants in this country to collect the total distillate of tar and pyroligneous acid in one large tank, from which it is pumped to a battery of settling tanks. The tar which separates in these contains 20 to 30 per cent of pyroligneous acid which is removed by distilling with a steam coil and live steam in copper stills. The condition of the remaining tar is such that further distillation for the purpose of recovering the tar oils is rendered difficult. WILLIAM E. CLIFFORD, of Memphis, Tenn., has found that the pyroligneous acid content of the tar from the settling tanks can be reduced to 2½ to 4 per cent by agitating with air at a temperature not above 85 deg. C. Treatment for two or three hours results in almost complete separation of the mixture into two layers. The tar can be successfully distilled in direct fired stills. (1,339,022; May 4, 1920.)

Carbo-Hydrogen Gas.—Carbo-hydrogen gas which is used in cutting and welding consists of approximately 85 per cent hydrogen and 15 per cent hydrocarbons of high heating value such as gases of the CH_4 and C_2H_2 series. According to JAMES R. ROSE, of Edgeworth, Pa., such a mixture is formed when methane or natural gas is fed into an electric arc through one of the electrodes. The hydrogen content can be varied by changing the rate of supply of the methane. Finely divided carbon is obtained as a by-product. (1,339,225; May 4, 1920.)

Aluminous Abrasive.—When abrasives are used in conjunction with an adhesive, such as glue, for abrasive purposes, in the form of an abrasive paper, cloth or buffing wheel, the efficiency of the abrasive depends largely upon the amount of adhesion between the grain and the glue. The amount of adhesion obtained is a function of the roughness of the surface of the abrasive. Artificial aluminous abrasives have normally a very smooth surface, and consequently, when used in conjunction with glue, do not exhibit this property of adhesion to the extent of certain abrasives having rough surfaces, such as natural emery. The smaller the crystals are, the rougher the surface will be. OTIS HUTCHINS, of Niagara Falls, N. Y., finds that the addition of strontium oxide reduces the size of the crystals in fused alumina abrasives. The charge may consist of 300 parts aluminous waste, 170 parts calcined bauxite and 30 parts strontium carbonate. (1,339,344; assigned to the Carborundum Co.; May 4, 1920.)

Sulphur Chloride.—A layer of molten sulphur is introduced into a steam-jacketed still and covered with sulphur chloride. Dry chlorine gas is passed in through a number of pipes which dip below the surface of the molten sulphur. As soon as the exothermic reaction is well under way the steam valve is closed and the temperature of the still controlled by regulating the temperature and rate of flow of water in a water jacket. The nature of the product is determined by: the depth of the $S + S_2Cl_2$ mixture in the still; the rate of flow of the chlorine; the temperature. To obtain pure sulphur monochloride, S_2Cl_2, the depth of the $S + S_2Cl_2$ is maintained equal to about 0.5 to 0.75 of the total depth of the still and the rate of flow of chlorine and the temperature are regulated until the temperature in the still head is 138 to 140 deg. C. Monochloride containing 5 per cent dissolved sulphur (such mixtures are used in the rubber trade) may be obtained by shutting off the cooling water so that the temperature in the still head rises to 225 deg. C. Sulphur dichloride will be formed when the depth of the $S + S_2Cl_2$ is decreased or the rate of flow of chlorine increased. The whole operation is preferably carried out under slightly diminished pressure. (1,341,423; RALPH E. GEGENHEIMER and MAX MAURAN, of Niagara Falls, N. Y., assignors to Mathieson Alkali Works; May 25, 1920.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Glycerine.—Glycerine is obtained by fermenting sugar in alkaline solution with or without the use of a catalyst. Suitable alkaline substances are: Ammonium phosphate, ammonium carbonate, sodium phosphate, carbonate or bicarbonate, an amine, a salt of an amine, or mixtures of these. Suitable sugars are: Grape sugar, invert sugar, saccharified starch, maltose, and purified molasses, or sirup. Commercial yeast, yeast cultures or other species of yeast may be used for fermenting, and food for the yeast may be added to the liquid. Manganese sulphate and iron sulphate are suitable catalysts. In an example, 20 g. of sugar and 140 g. of disodium hydrogen phosphate are dissolved in 2 l. of water and fermented by 50 g. of commercial yeast at 30 deg. C. The liquid is afterward decolorized by boiling with animal charcoal, filtered, evaporated, and the glycerine extracted by alcohol, which is then distilled off. The yield is 12 per cent of the sugar. The fermented liquid may be purified by lime, magnesia, or iron compounds before concentration. (Br. Pat. 138,099—1919. VER. CHEMISCHE WERKE AKT. GES., Berlin. See also patents 138,328—1919 to 138,331—1919, March 24, 1920.)

Purifying Oils.—The bleaching and refining of oils, fats and other substances by means of earths, such as fullers earth, "tonsil" and "panconite," is conducted in the presence of hydrogen. In an example a strong current of hydrogen is passed through 1 kg. of rapeseed oil and 50 g. of "tonsil" gradually raised to 250 deg. C. and maintained at this temperature for 4 to 5 hr.; the mass is allowed to cool to 80 deg. C. and filtered. Oils and fats so treated are said to be particularly suitable for hardening by catalytic processes. (Br. Pat. 138,115—1919. V. SCHWARZKOPF, Bremen, March 31, 1920.)

Cellulose Compounds.—A cellulose compound suitable for use in the manufacture of non-inflammable films and in the preparation of a substitute for gelatine is prepared by treating ordinary or mercerized cellulose with a halogenized fatty acid such as chloracetic or chlorpropionic acid, in the presence of caustic alkali. In an example, cellulose is mercerized in alcoholic soda lye, separated from the excess of soda lye, treated with monochloracetic acid, and the mixture left to stand; when the reaction is complete, water is added with stirring to form a clear thick paste which is neutralized and from which the compound is afterward precipitated by the addition of alcohol. In another example, mercerized cellulose is moistened with soda lye and kneaded with the sodium salt of monochloracetic acid suspended in alcohol; when perfect solubility in water is obtained excess of liquid is removed, and the products washed with dilute alcohol, and then neutralized. The sodium salt so obtained dissolves readily in hot or cold water, forming clear viscous solutions. The free acid resembles cellulose; the copper, lead and aluminum salts are insoluble in water. (Br. Pat. 138,116—1919. DEUTSCHE CELLULOID FABRIK., Eilenburg, March 31, 1920.)

Nitrogen Oxides.—In the production of nitrogen oxides by the catalytic oxidation of ammonia by air, loss of heat is prevented and the reaction rendered self-supporting by arranging in front of a platinum gauze diaphragm, which is the catalytic material, and in proximity thereto one or more screens of metal gauze such as nickel, which is non-catalytic toward ammonia. This screen receives the heat radiated from the diaphragm or conducts the heat therefrom, and thereby acts as a pre-heater for the gases. For similar purposes another screen is arranged to the rear of the diaphragm. In addition to the use of the first screen as a pre-heater, it also serves to remove dust and to oxidize impurities such as hydrocarbons or sulphur present in the gases, which tend to poison the catalyst. (Br. Pat. 137,036—1919. C. TONIOLO, Legnano, Italy, Feb. 18, 1920.)

Alloy.—An alloy specially suitable for making castings for floats for feed water regulators and for other purposes where the articles are subjected to high temperatures and pressures is made by first preparing a white metal alloy of 61 per cent tin, 29.7 per cent copper and 9.3 per cent zinc, and afterward mixing 19.64 per cent of this alloy with 80.36 per cent of copper. (Br. Pat. 138,228—1919. A. G. MUMFORD, Colchester, March 31, 1920.)

Alkaline Earth Chlorides.—An alkaline earth sulphate, such as barytes, celestite or gypsum, is heated with magnesium chloride and coal or other carbonaceous reducing agent. Sulphuretted hydrogen is evolved and an alkaline earth chloride and magnesia are produced. The alkaline earth chloride is leached out, and the magnesia may be dissolved in sulphuric acid. When it is desired to make barium sulphate by treating the barium chloride with sulphuric acid, the hydrochloric acid evolved may be used to convert the magnesia into magnesium chloride so as to make the process cyclic. The alkaline earth sulphate may be heated with magnesium chloride without a reducing agent, at a higher temperature, but with inferior yield of alkaline earth chloride. Br. Pat. 138,486—1919. F. B. SCHOTOFF, Gwalior, India, April, 1920.)

Chrome Alum.—Chrome alum is obtained by dissolving ferrochrome in sulphuric acid, the ferrochrome being ground to a fine powder and the mixture well heated and stirred, and adding a soluble potassium salt to the resulting solution of chromic and ferrous sulphates, when pure chrome alum is crystallized out. The content of iron may be previously reduced by in part crystallizing out the ferrous sulphate. The solution of ferrochrome in sulphuric acid proceeds more rapidly in leaden vessels. (Br. Pat. 138,594—1919. G. H. HULTMAN, Stockholm, April 8, 1920.)

Detinning Process.—Tin waste materials containing tin in the form of sulphide, oxide, oxychloride, etc., are dissolved in hydrochloric acid in presence of an oxidizing agent such as niter or chlorine and heat, and the solution is then reduced to obtain stannous chloride by means of tin waste containing metallic tin, such as tinplate. The stannous chloride solution is electrolyzed, using carbon or scrap tin or iron-tin alloy as anode and sheet iron or tin as cathode. The electrolysis is started at 0.5 to 1 volt and is interrupted when the pressure rises to 2 volts. The spent electrolyte in presence of an oxidizing agent is then used as solvent for the waste tin compounds and the process is continued as above described. (Br. Pat. 138,622—1919. T. A. ELKUNE, Stockholm, April 14, 1920.)

Melting and Refining Metals.—Metals and alloys are melted and subjected to a prolonged action of a vacuum. Spongy and powdered metals may thus be converted to a coherent state. (Br. Pat. 138,648—1919. HERAEUS GES. HANAU. See also 138,651—1919. April 14, 1920.)

Synopsis of Recent Chemical & Metallurgical Literature

Effects of Strain and of Heat Treatment on Metal Structure.—The more or less slow changes in crystalline structure which take place in metals after cold work and after annealing can, according to S. NISHIKWA and G. ASAHARA, be followed by means of X-ray examination. They apply (*Physical Review*, January, 1920, pp. 38 to 45) the original method of Laue, by letting a pencil of the rays, 3 mm. in diameter, fall normally on the rolled sheet of metal (from 0.1 mm. to 0.54 mm. in thickness); the sheet is fixed about 5 cm. from the photographic plate on which spots grouped in characteristic patterns are produced.

Rolled aluminum, cadmium, copper, zinc and brass gave ill-defined patterns, but a symmetry with respect to the direction of rolling was noticeable. Silver and tin showed similar patterns immediately after rolling; when the specimens were kept at ordinary temperature for a week or two, the patterns changed into those characteristic of the annealed metals. In the case of lead and thallium no symmetry was visible after rolling, indicating either that the rolling did not distort the structure or that the crystalline recovery is rapid. The annealing was effected in an electric furnace at temperatures up to 800 deg. C. The metals, of course, differed greatly in their response to annealing. In the case of silver and tin, annealing for 30 min. at 80 deg. sufficed to obliterate all traces of the previous cold work; for copper, 2 hr. at 800 deg. was insufficient. Thallium annealed at various temperatures from 100 deg. up to 250 deg. indicated the existence of a transformation point at 227 deg. C., which would agree with observations by other methods; in tin, however, the X-ray examination did not reveal any transformation near 160 deg.

Arnold's Vanadium-Molybdenum High-Speed Steel.—In view of the excited comment in America following the newspaper announcement of a sealed patent given J. D. ARNOLD for an improved high-speed steel, a brief article by him in *The Engineer*, May 7, 1920, p. 480, will be interesting. After briefly recounting the history of Sheffield tool steels, he remarks that their steel first produced in 1892-93 containing C 0.6 per cent, Cr 4.0 per cent, W 20.0 per cent "marked the high-water mark in quality of high-speed steel." The cutting power was doubled about 1896-97 by adding to it about 1 to 1.5 per cent of Va and this composition represented the best efforts of metallurgists for many years.

"The patent taken out by the present writer in 1918 substituted, say, 6 per cent of Mo associated with a little over 1 per cent of Va, the key element of the chemical composition." This produces a steel distinctly better than the 1896-97 combination, providing the heat treatment specified is carefully carried out. The author emphasizes this point, that the heat-treatment specification is as indispensable as the chemical specification—a requirement honored largely by its neglect in America. "The functions of the key element Va appear to be: (*a*) The stabilization of the variable properties of molybdenum steel, and (*b*) the prevention of cracking during the water-hardening operation, thus securing a steel not only of notable hardness but also of remarkable thermal stability." It does not "let down" until about 700 deg. C., as compared to 300 deg. C., which ruins a carbon tool, or 550 deg. C., a temperature where low-grade high-speed steel rapidly becomes useless.

Fifty Years' Progress in Iron and Steel.—Dr. J. E. STEAD'S presidential address before the recent meeting of the Iron and Steel Institute was a very voluminous review of the industry for the past half century, covering a wide range of collateral subjects in great detail. English blast furnaces have not followed the American lead in great size and hard driving, except in one notable instance, which, as a matter of fact, did not produce iron any more cheaply than the smaller English stacks. Britishers believe that rapid driving means brief life of linings and low-silicon iron, which latter is especially undesirable for local hematite users requiring pig iron containing from 2 to 3 per cent Si. One great advance is general adoption of modern recording pyrometers for indicating blast temperature. However, despite every metallurgical effort, the general deterioration of coke quality has actually increased its consumption per ton of pig delivered. If but one-third of the heat wasted in slag could be recovered, this would reduce the fuel consumption approximately 100 lb.—a total saving of 350,000 tons coke per year, a result worthy of the best efforts of engineers.

Puddling requires fundamental reorganization. Liquid blast-furnace metal should first be dephosphorized and reduced to 1.75 per cent carbon in a tilting basic open-hearth furnace, and then transferred to a rotary furnace with permanent lining, there to be further refined by adding the exact amount of melted cinder.

Basic steel makes very slow headway, due, in Dr. Stead's opinion, to prejudice inherited from the early days when the new product was somewhat non-uniform. Acid open-hearth steel, however, is supplanting bessemer metal—not a single converter is in operation in any large works on the northeast coast. Armco iron is now being made in England by the Shelton Iron & Steel Co., and during the war was substituted for Swedish iron in the manufacture of crucible steel with most satisfactory results.

Electric furnaces increased in great number during the war, the combined available capacity now being about 300,000 tons per year. This tonnage is less than that of Germany, largely due to the fact that British furnaces melt scrap, while German furnaces refine hot basic bessemer metal. On the Tyne electric steel is being made at a price competing wth acid open-hearth, cheap power being available from coke-oven gas.

Interesting byproducts of the change in smelting practice from basic bessemer to basic open-hearth mentioned by Dr. Stead are the decreased demand for high-phosphorus puddling cinder to make high-phosphorus bessemer pig, and the decreasing amount of basic slag the farmer so tardily recognized as being the phosphorus fertilizer par excellence. Open-hearth slag has reduced phosphoric acid to about 11 per cent, and the solubility is often further lessened by the use of fluorspar or $CaCl_2$ during the heat.

Current Events
in the Chemical and Metallurgical Industries

Contempt Proceedings Dismissed

The following is the full text of the decision of Judge Bourquin in the contempt proceedings instituted by Minerals Separation against the Butte & Superior Mining Co.:

Minerals Separation, Ltd. vs. Butte & Superior Mining Co. } Contempt Proceedings

JUDGE BOURQUIN: Subsequent to the decision of the Supreme Court of the United States and pending accounting herein complainants instituted these proceedings in civil contempt based upon allegations that an account filed herein by defendant discloses it was and has been operating with methods of the patent process with less than 1 per cent of oil and contrary to the injunction. Hearing was had and it appears that at the head of the machine (see 245 *Fed. Rep.*, p. 583 for description) defendant adds to the pulp less than 1 per cent of oil but that the circulating load there entering the pulp contains sufficient oil to constitute the total 1 per cent and more. It incidentally appears that when the pulp arrives at the tail cells, at last of the machines, the oil is less than 1 per cent. Complainants contend that the oil in the circulating load is without efficacy and that both the situations aforesaid involve use of oil less than 1 per cent and are contrary to the injunction and contempt. During proceedings upon the merits, complainants urged that both these situations then existed and involved infringement, but not being vital and being rather doubtful in respects to both facts and law, the courts made no express reference or decision in respect to them. To now conclude that the Supreme Court's decision impliedly determines them favorably to complainants is mere conjecture and inadmissible. That either situation involves infringement and violation of the injunction is by no means clear. In these circumstances, having also in mind the severity and delays of contempt proceedings to the defeated party, complainants cannot be permitted to transfer the controversy from the merits to contempt. They must fully litigate upon the merits what they have half litigated so that the defeated party may have prompt review rather than suffer hardships from delays due to inability to appeal from the decision in contempt until some time after final decree in accounting. It is believed equity, patent law, discretion requires that complainants be remitted to some one of the familiar methods to secure determination upon the merits of these alleged infringements. Accordingly the contempt proceedings are dismissed.

The National Research Council Elects Officers

The National Research Council has elected the following officers for the year beginning July 1, 1920: Chairman, H. A. Bumstead, professor of physics and director of the Sloane Physical Laboratory, Yale University; first vice-chairman, C. D. Walcott, president of the National Academy of Sciences and secretary of the Smithsonian Institution; second vice-chairman, Gano Dunn, president of the J. G. White Engineering Corporation, New York; third vice-chairman, R. A. Milliken, professor of physics, University of Chicago; permanent secretary, Vernon Kellogg, professor of entomology, Stanford University; treasurer, F. L. Ransome, treasurer of the National Academy of Sciences. All of the chairmen of the various divisions of the Council have not yet been selected, but will be announced later.

New Nitrogen Fixation Plant at Syracuse

The Atmospheric Nitrogen Corporation, a company organized and incorporated in New York State with an authorized capital stock of $5,000,000 by the General Chemical Co. and the Solvay Process Co., has purchased a 60-acre tract of land near the Solvay Process Co.'s works on the western outskirts of Syracuse, N. Y.

Ground has already been broken for a new plant to manufacture 20,000 lb. anhydrous ammonia per day on a plan worked out by DeJahn, similar to the Haber process, using hydrogen from water gas, nitrogen from the air, and a suitable catalyst.

An interesting feature of the plant is the utilization of the byproducts. CO from the water gas is to be converted into CO_2, which will be used by the Solvay Process Co. as a raw material in its manufacture of soda ash, and in return, coke, a byproduct of the Solvay process, will be used to make water gas, thus closely correlating the operations of the two plants.

At present under the direction of the J. G. White Engineering Corporation of New York the company is erecting a process building, gas producer, two large gas holders, service buildings and boiler house, all of steel and brick construction, at an approximate cost of $2,500,000. Electric power will be furnished by the Niagara, Lockport & Ontario Power Co. from Niagara Falls.

Citations by Federal Trade Commission

The Federal Trade Commission has cited the following concerns for unfair competition in trade:

John Bene & Sons, Inc., Brooklyn, for compounding and selling hydrogen peroxide.

Samuel Weinberg, doing business under the name of the International Flaxol Co. at Boston, Mass. This company advertises and sells a certain commodity which it has named "Flaxol," thereby indicating that it is a derivative of flax and the equivalent of well-known products of flax, such as linseed oil, sometimes called flaxseed oil.

The United Indigo & Chemical Co., Ltd., Boston, Mass., which is engaged in the manufacture and sale in interstate commerce of dyestuffs, chemicals and other dyeing goods and products. This company is accused of secretly giving cash commissions and other rewards to employees of its customers and its competitors' customers to induce the purchase of its products.

Forty days have been given these companies to reply, after which the cases will be set down for trial on their merits.

Chicago Chemists Inaugurate Weekly Luncheon

The first regular weekly luncheon of the Chicago Chemists' Club was held on June 1 at the club quarters. Dr. A. I. Kendall, dean of Northwestern Medical School, delivered a most interesting discourse on industrial bacteria. Among the out-of-town visitors were Dr. A. V. H. Mory, of Cincinnati, and H. C. Parmelee, editor of CHEMICAL & METALLURGICAL ENGINEERING.

Budget Bill Rejected

The bill to create a national budget system, which was vetoed by President Wilson, was amended by the House to conform with the President's views and was again passed, but the Senate failed to take any action in the matter because of the opposition to the measure by Senators Harris and Reed. Anticipating the provision of budget system, the House of Representatives provided for the reorganization of its appropriations committees, forming a single committee of thirty-five members to replace the eight committees which previously had handled various parts of this work. The Smoot-Reavis resolution providing an investigation of the Federal executive departments, in anticipation of complete reorganization, was defeated in the House of Representatives by a strict party vote. The Democratic membership opposed the measure on the ground that the director of the budget should do this work, but the failure of the budget bill subsequently leaves the matter without any agency to conduct the investigation contemplated.

Byproduct Coke Plant at Birmingham, Ala., Completed

The Sloss-Sheffield Steel & Iron Co. has just completed a new byproduct coke plant at its works in Birmingham, Ala., at a cost of approximately $2,500,000. Equipment includes 120 Semet-Solvay coke ovens, buildings for byproducts, cooling pond, machine shop, engine house, stacks, offices, etc., and two 2,000-kw. electric turbines. Additional 2,000 hp. is transmitted from an electric plant about two miles away.

This plant will consume 2,500 tons of soft coal per day and yield 20,000 gal. of crude tar, 60,000 lb. of ammonium sulphate or its equivalent in liquor, 7,000 gal. of light oil, and 7,000,000 cu.ft. of marketable fuel gas in addition to that required for plant operations. About 2,000 tons of coke, or enough to operate the company's five blast furnaces, will also be produced.

Fund to Investigate Power Supply

The U. S. Geological Survey received a fund of $125,000 with authority to accept additional sums to be expended by it for an investigation of power supply throughout the Washington to Boston territory. This so-called super-power investigation contemplates a study of water-power and fuel-power developments that will undoubtedly demand consideration of byproduct coking, large steam power plants and all other possibilities. The technical, economic and resource conservation aspects of each situation will receive attention. It is hoped, therefore, that the industrial chemical possibilities of fuel-using industries will receive considerable attention in the investigation.

Great Western Sugar Co. to Build New Plant

Announcement has been made that the Great Western Sugar Co. is to erect a 600-ton plant in Weld County, Colorado, at the junction of the Union Pacific and Great Western railroads. This plant is expected to be ready for operation by next October and is similar to the Brighton plant.

This plant will have a great advantage in being situated in one of the finest sugar beet-growing sections in Colorado.

Chemical Warfare Service Continues

Under the provisions of the Army reorganization bill the Chemical Warfare Service has been continued as a permanent branch of the Army. The present provision is for 100 officers and 1,200 men, the command being headed by a Brigadier General. The appropriation bills for the coming fiscal year provide new appropriations of about $2,000,000 in addition to approximately $2,000,000 available in funds which continue for the coming fiscal period. Approximately $25,000,000 of the funds available during the past and previous years, however, revert to the Treasury unused.

All regular Army officers in this service as well as other services revert to their regular Army rank on June 30, as emergency commissions in all grades are cancelled as of that date.

Any persons contemplating application for commissions in this service must make application on form 739 before June 23.

In contrast with the continuation of this service is the fact that the construction corps was not provided for, as had been expected.

New Jersey Chemical Society Year Book

Although the New Jersey Chemical Society was organized less than two years ago, it has already assumed a position of importance among the scientific societies of the metropolitan district. Its rapid rise is best understood from a study of the recently issued year book. In this the reasons for the formation of the society are set forth, followed by a brief review of the activities and meetings of the society from Nov. 11, 1918, to Feb. 9, 1920.

In order to increase the usefulness of the volume, a chapter on chemical education in New Jersey, a list of chemical and allied periodicals available for reference in the Newark Public Library, and a classified index of chemical manufacturers and supply houses in the state have been included. The classified index also serves to indicate the extensive and varied chemical industries which form the foundation of this society and which guarantee its successful development.

Increase of Salaries for Government Technical Men Contemplated

Continuing the effort to secure better salaries for the technical services of the Government, a number of scientific men have actively participated with others in the appointment of committees to work during the summer on this problem. Two sets of committees are being provided: the first to consider classification of present employees under the system which has been recommended to Congress; and the second group of committees, one from each department, to aid in the publicity and educational work required to make the needs of the services generally known.

Internal Revenue Bureau After Alcohol in Patent Medicines

In order to minimize the consumption of patent medicines for beverage purposes where an appreciable percentage of alcohol is contained, the chemical division of the Internal Revenue Bureau is making special effort to have manufacturers of these preparations change their formulas by adding some ingredient which will discourage beverage use.

British Units to Be Used in War Department

To avoid confusion, the Secretary of War has ordered the British units of weight and measure be used as far as is practicable. The instructions issued in that connection are as follows:

"As an incident to the World War, metric units of weight measure were necessarily used in instruction and training. As a result, more or less confusion now exists as to what units should be used normally. Hereafter, the customary former units of weight and measure (including the degree Fahrenheit) will, as far as practicable, be used throughout the Army as they were before the war.

"Material and equipment now graduated in metric units will, when worn out, be replaced by articles graduated in British units in such manner as will cause all parts of a regiment or similar organization (or smaller organization when there is no regimental organization) to be provided at all times with material and equipment graduated alike.

"This order shall not be construed to prevent the utilization of metric units of weight and measure when desirable in connection with specifications and contracts, medical and scientific supplies, scientific research and developments, international meteorology, foreign maps, monographs and handbooks and similar subjects."

Hongkong Markets Shut Out American Dyes

Consul General George E. Anderson at Hongkong points out in a brief survey of the American dye industry in southern China that the United States has built up quite an extensive trade in aniline dyes and synthetic indigo during the last two years. Switzerland also shipped considerable quantities during 1919 and was one of the chief competitors in the trade.

At that time Great Britain was not exporting colors to China. Suddenly after the trade with United States was fairly well established, the Hongkong Government, at the behest of the Imperial Government in London, prohibited the importation of any but British manufactured dyes, thus shutting out American products except for reshipment. This of course gives the British dye makers a decided advantage over foreign competitors, but as they have not met the demands of the trade in the way that was expected the result has been to throw the entire dye industry into a state of uncertainty while plans are being considered to relieve the situation.

War Minerals Relief Act Amendment Fails

The war minerals relief act amendment which was intended to put war minerals claimants on the same footing as claimants seeking relief from other contract losses passed the Senate shortly before the end of the Congressional session. However, it contained an error which made it ineffective and a resolution to correct this was not considered. The bill did not receive consideration in the House of Representatives.

Japan Shipping Sugar to United States

Advantage of the high price of raw sugar is being taken advantage of by the Japanese sugar merchants to ship their surplus stock. The price of refined sugar in Japan has been 15c., but has now risen to 18c.

Consignment of Swiss Dyes Arrives

A large quantity of Swiss dyes consisting of 181 cylinders of assorted colors from Havre arrived recently. This shipment was consigned to New York firms which, it is understood, have already disposed of most of the consignment.

Although up to the present time there has been a ready market for foreign dyes, it is admitted in the trade that demand from the textile industry is disappointing. Settlement of the labor difficulties among the textile plants has not resulted in the expected increase in activity in the industry. Tightening of credits by banks, a lessening in public buying, together with the freight congestion due to strikes and difficulty in transportation of raw materials and finished products, have had a depressing effect.

Output of direct colors has been limited due to scarcity of H acid, while shortage of dimethylaniline has restricted production of basic colors. The vat color situation has somewhat improved. Two large concerns have been reported as about to market a wide range of fast colors equal to those produced by German or other foreign manufacturers. Vat yellow R is the only item that is being produced in quantity in this list at present.

Wool green S, rhodamine and patent blue are to be put on the market on a large scale as soon as general business conditions will warrant it.

Meeting of the New Haven Section, A. C. S.

The May meeting of the New Haven Section, A. C. S., was held May 14 at the Graduates Club, New Haven, Conn. After dinner at the club, a short business meeting was held, presided over by President Walter R. Hibberd. It was voted at this meeting not to publish in the *Chemiker Zeitung* results of research in chemistry by members of the society. After the meeting the members gathered at the Kent Laboratory to hear the lecture by E. M. Symes, assistant chief chemist of the Hercules Powder Co., on "The Manufacture of Dynamite and Gelatine, Including the Manufacture of Nitric and Sulphuric Acids."

This lecture was well illustrated by both moving pictures and lantern slides, and gave in a general way a good idea of the processes used and also the plants of the company.

Some idea of the tremendous force of some of the explosives manufactured was shown when 700,000 tons of rock were broken down by one blast of 120,000 lb. of dynamite at a cost of $12,500. The whole face of a cliff about 600 ft. long and 150 ft. high was blown off at one charge.

The lecture was well attended by both students and members of the society.

German Syndicate to Operate Spanish Potash Deposits

Reports are current to the effect that German interests have acquired control of Spanish potash production and that German capital and labor will work the deposits. Herr Gunte and Herr Ziervogel, two potash experts, have examined and reported on the deposits, with the result that important concessions for working these deposits are expected to be made to the German syndicate by the Spanish Government.

Swansea Patent Fuel Industry

Consul A. B. Cook reports that five patent fuel works in the city of Swansea and one plant at the sub-port of Port Talbot are now in operation. These plants are engaged in the manufacture of briquets from coal dust, a byproduct of the local coal mines.

Port statistics show reports of patent fuel from Swansea and Port Talbot as follows: 1918, 1,014,603 long tons; 1919, 1,092,803 tons; first three months of 1920, 329,402 tons.

Large quantities of tar and pitch required as a binding material are imported, as there is no production of them in Great Britain.

Personal

Prof. CHARLES BASKERVILLE, in recognition of his investigations on inhalation anesthetics, has been elected a member of the research committee of the National Anesthesia Research Society.

KENNETH E. BELL has resigned his position of research associate, research laboratory of applied chemistry, Massachusetts Institute of Technology, to accept one as chemical engineer with the Lewis Recovery Corporation of Boston.

W. F. BLEECKER of the Tungsten Products Co., Boulder, Col., has just completed an extended trip through Eastern points.

Dr. MARSTON TAYLOR BOGERT, professor of organic chemistry in Columbia University, has been appointed by President Wilson as a member of the United States Tariff Commission.

W. C. BUELL, JR., formerly engineer of tests and later chief engineer of Tate-Jones & Co., Inc., on June 1 became associated with the George J. Hagan Co., Pittsburgh, Pa., as chief engineer of the newly organized liquid fuel department.

HARMON F. FISHER has been engaged by the United States Bureau of Mines as liquefaction engineer in charge of the helium experimental plant at Petrolia, Tex.

LUCIEN H. GREATHOUSE recently resigned as assistant chemist of the Fixed Nitrogen Research Laboratory, War Department, to accept a position in experimental work with the Atmospheric Nitrogen Corporation, Laurel Hill, N. Y.

GUY C. HOWARD of the Tacoma Smelting Co., Tacoma, Wash., is visiting New York City and other Eastern points on a business trip.

A. H. KROM, assistant secretary of the American Association of Engineers, has resigned to enter business. Mr. Krom was one of the organizers of the association.

Dr. C. E. K. MEES, director of the research laboratories of the Eastman Kodak Co., Rochester, N. Y., will deliver lectures on various aspects of photographing and on the general subject of industrial research before various scientific bodies while he is in England.

H. C. PARMELEE, editor of CHEMICAL & METALLURGICAL ENGINEERING, has returned from a two months' trip to the Pacific Coast, visiting St. Louis, Omaha, Denver, Pueblo, Salt Lake City, Los Angeles, San Francisco, Portland, Tacoma and Seattle.

G. ARNCLIFFE PERCIVAL has arrived in New York City from England and expects to make a close study, from the technical point of view, of some of the larger industrial plants of this country.

The board of directors of the American Electrochemical Society at its meeting April 30 appointed the following executive committee: W. S. Landis, chairman, ex officio; J. W. Richards, ex officio; H. B. Coho, J. V. N. Dorr, C. G. Fink, Carl Hering and H. C. Parmelee.

Current Market Reports

The Non-Ferrous Metal Market

New York, June 11, 1920.—Copper market slightly weaker, with one large producer reported to be willing to sell at 17½c. on large tonnages. Large stocks are on hand. Tin has declined 5 points, to 46c., in sympathy with the London market.

	Cents per Lb.
Copper, electrolytic	18.50
Aluminum, 98 to 99 per cent.	32@33
Antimony, wholesale lots	8.87½
Nickel, ordinary	45.00
Nickel, electrolytic	45.00
Tin, Straits, spot	46.00
Lead, New York, spot	.0
Lead, E. St. Louis, spot	8.50
Zinc, spot, New York	7.90
Zinc, spot, E. St. Louis	7.55

OTHER METALS		
Silver (June 10)	oz.	$0.87
Cadmium	lb.	1.40@1.50
Bismuth, (500-lb. lots)	lb.	2.70@3.00
Cobalt	lb.	2.30@3.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.60@1.85
Platinum	oz.	90@95
Iridium	oz.	300@400
Palladium	oz.	90@100
Mercury	75 lb.	93.00

FINISHED METAL PRODUCTS	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	33.50
Copper bottoms	38.00
Copper rods	38.00@40.00
High brass wire and sheets	30.25
High brass rods	25.00
Low brass wire and sheets	28.50
Low brass rods	29.00
Brazed brass tubing	43.25
Brazed bronze tubing	41.75
Seamless copper tubing	34.00
Seamless high brass tubing	33.00

SCRAP METALS	Cents per Lb. Buying Price
Aluminum, cast scrap	24.00@25.50
Aluminum, sheet scrap	24.00@25.50
Copper, heavy machinery comp.	15.00@16.00
Copper, heavy and wire	15.50@16.00
Copper, light and bottoms	14.00@14.50
Copper, heavy cut and crucible	16.25@16.75
Brass, heavy	9.50@10.00
Brass, light	8.00@8.50
No. 1 clean brass turnings	9.25@9.75
No. 1 comp. turnings	13.50@14.00
Lead, tea	5.00@5.50
Lead, heavy	7.00@7.25
Zinc, scrap	5.00@5.25

The Iron and Steel Market

Pittsburgh, Pa., June 11, 1920.

The American Iron and Steel Institute reports that in May 2,883,164 tons of steel ingots was produced by thirty companies which in 1918 made 84.03 per cent of the total output. Allowing for unreported production and computing annual rates on the basis of the number of working days, the annual rates in each month this year, in gross tons, are found to have been approximately as follows: January, 40,700,000; February, 44,200,000; March, 45,200,000; April, 37,550,000; May, 41,050,000.

The rail strike began April 1, but did not seriously affect the valleys, the lake front and Pittsburgh until about Monday, April 12. The low point in pig-iron and steel production fell at about that time or shortly after, and there was only slight recovery during April, while during May the improvement grew more and more pronounced. One may therefore conclude that a low point in production fell at about the middle of April, under 34,000,000 tons per annum, and that the rate at the close of May was nearly if not quite 43,000,000 tons. As conditions have continued to improve, it seems probable that a 45,000,000-ton rate will be regained by the end of this month.

SHIPPING CONDITIONS BETTER

Car supplies are improving at nearly all points, but at a slow rate. A few mills may now be shipping as much steel as they produce, but in general a little is still accu-

mulating, and it may be the end of the month before there is an even break. Past experience with freight congestions has been that the beginning of relief is the difficult matter, and that as small inroads are made at congested yards the improvement grows apace. It is on account of such analysis, rather than on account of the actual improvement that has occurred to date, that the steel makers have their present sanguine views as to the nearby future of transportation conditions. At the same time it is recognized that if the railroads get into normal working order they will not be able to carry much of an overload, hence it will probably require a long time to work off all the steel now stocked at mills, probably between 1,500,000 and 2,000,000 tons.

There are conflicting reports as to the relation between shipments and receipts of finished steel. At some mills the claim is made that although cars are being loaded they are not reaching destinations in fair time, which would mean that the number of loaded cars is increasing. From this it would be far from difficult to deduce that the number of empty cars available for loading would be decreasing. In other quarters, however, the observation is that loaded cars are reaching consignees much more freely than formerly, which would mean that more cars are getting into service and that practical progress is being made.

In the matter of both coal and coke there is a freer movement. Even for last week, when there was a holiday to interfere, the Connellsville *Courier* reported a slight increase in coke production in the Connellsville and lower Connellsville region. Car supplies to the Pittsburgh coal district are slightly increased.

Trends in Order Books

The Steel Corporation and the independents are getting farther and farther apart as to the size of their respective order books. May was described by independents as a dull month marketwise, and there is no doubt that it was decidedly dull from that viewpoint. On the other hand the Steel Corporation's report of unfilled obligations at the end of May shows that the corporation's bookings during the month were not simply in excess of the month's shipments but in excess of a full month's capacity. The increase was 580,719 tons, to 10,940,466 tons, the increase being equal to 44 per cent of capacity, on the corporation's own rating of 52,500 tons per working day. The month's shipments may be estimated at about 68 per cent of capacity, which would make the bookings in the month 112 per cent of capacity. Bookings similarly computed were 94 per cent in April, 124 per cent in March, 108 per cent in February and 162 per cent in January.

The unfilled obligations at the beginning of June would carry the corporation, at 52,500 tons per working day, to about Feb. 6, 1921, as an average date, or to about March 1 on the basis of a 90 per cent operation. Of course the orders are not equally distributed according to capacity of the various departments, so that such dates are merely average.

Prices of Larger Mills Firm

The independents as a whole are not booked one-half as far ahead as the Steel Corporation, though of course they have understandings with various customers to supply them with monthly quotas of steel, at prices to be set from time to time. The independents, having prices higher than those of the Steel Corporation, cannot secure orders for the late deliveries that are acceptable to Steel Corporation customers, while they cannot reduce prices without jeopardizing some of the business they now have on books. This is a principle that has always obtained in the steel trade when demand tends to fall off, but in former cases all producers were in much the same position. The mills with but little business ahead have been yielding in their prices for several weeks past, but the larger mills, booked for two to five months ahead, have been standing quite firm. Apart from the smaller mills with the leanest order books being disposed of their own accord to ask smaller delivery premiums there is another influence, that some of the mills booked for several months ahead have lately been finding it possible to make quite early deliveries at their regular prices, and this again has tended to bring down prices in the prompt market. A few weeks ago the condition was clearly defined of there being three markets, one prompt market, the moderately extended delivery market, two to five months, and the far forward market, made by the Steel Corporation. Now it can hardly be said that there are more than two markets, one for prompt or moderately early delivery and one for extended delivery, the Steel Corporation being alone in that market.

Pig Iron

Merchant furnaces can now reach almost all their customers with deliveries, and the demand for spot or prompt iron has dwindled to very small proportions, while no particular interest is aroused in late deliveries. Some furnaces now have fairly large stocks, owing to the traffic difficulties, but consumers, on the other hand, are rather bare of stocks. The market is stagnant, with no change in quotable prices, which remain: Bessemer, $43; basic, $43.50; foundry, $45, f.o.b. valley furnaces, freight to Pittsburgh being $1.40.

Semi-Finished Steel

Billets are stagnant, quotable at the last market of $60@$65, consumers being interested in deliveries of steel already ordered rather than in the making of fresh purchases. To an extent the same condition obtains in sheet bars, but there is some business from time to time. The last sale reported is of a round tonnage of bessemer bars, two or three months' delivery beginning July 1, at $75, the transaction indicating a slightly stronger tone in the bessemer market than had been assumed. Open-hearth bars are $75@$80.

Finished Steel

The merchant bar list is now split, as to early deliveries, small sizes being so scarce that a higher base, up to 4c., obtains than on moderate and large sizes, which can be done even for early shipment at about 3c.

The season cotton tie price of the Carnegie Steel Co. has been announced at $2, this being the price in lots of 3,000 bundles or more, 45 lb. per bundle, for June shipment, the carrying charge for later deliveries being 1½c. a month. One of the independents at least will follow this price, but another announces it will make no ties, and will probably await the possible development of a scarcity and bids at higher figures.

Ferro-Alloys

While small prompt lots of forromanganese might bring close to $250, delivered, the market has continued to ease off. Second half or third quarter contracts remain at $200, delivered, with little interest exhibited. Spiegeleisen remains quiet at $72.50@$75, furnace. Electrolytic ferrosilicon is stagnant, prices being largely nominal at about $78@$80 for 50 per cent and $150@$155 for 75 per cent. Bessemer ferrosilicon remains at $62.50 for 10 per cent, $65.80 for 11 per cent and $69.10 for 12 per cent, f.o.b. furnaces at New Straitsville and Jackson, Ohio.

The Chemical and Allied Industrial Markets

New York, June 11, 1920.

Changes in the chemical market during the interval have been very few and confined to the more active items of the list. Producers are limiting their output for one of two reasons; recently the theory has been advanced that a slump in the market is anticipated and the manufacturer is wary of being caught with stored supplies on hand, but the more obvious reason is the pronounced shortage of cars at the plants in which to ship the product. As a result the market remains in a strained condition with spot supplies very low and selling at a premium.

Acetic acid, glacial, 99½ per cent, is firmer at $16.50@$17.50 per cwt. than it was last week, with buying interests considerably more active. *Oxalic crystals* is in a similar position and 60@65c. per lb. is the ruling figure for spot material. The heavy chemicals have been well sustained with the exception of *potassium prussiate*, yellow, which came down slightly and is now listed at 35@36c. per lb.

for less than car lots, against 36½@37½c. of the last report. Enough has been said about the more active items on the list, so it is sufficient to say that *bleaching powder, ammonia* and *barium* products, *epsom salts* and *soda ash* remain in the same nominal position, with prices quoted varying according to the necessity of the buyer. Offerings of *potassium* and *sodium bichromate* (resale material) have been received from Japan at figures below the present market, but so far buyers have refrained from contracting because of the uncertainty as to the condition of the material and the possibility of prompt delivery.

Coal-Tar Products

As has been said frequently and truthfully, there is no activity in prices or of material changing hands in this market. Slight as it is, there is a still further decline being noticed in some quarters due to the coming summer season, but there is so very little material being offered and so few buyers at the prevailing prices that it is hardly worth while noting. On the other hand, *alpha-naphthol*, crude, is being offered at $1.40@$1.50 and refined at $1.60@$1.70, against $1.35 and $1.50, respectively, as high-water marks of the previous week. *Naphthalene* shows no signs of decline and former figures of 15@17c. per lb. for *flake* and 16@18c. per lb. for *balls* hold firm.

Waxes

The *paraffines* furnish the only interesting movement in this branch. For the past few months this movement has been steadily upward and according to many there is no break in sight, either in demand or in prices, The available stocks are so small as almost to warrant placing these waxes in a nominal position. The other grades—*carnauba* and *bees*—are plentiful with moderate orders.

Naval Stores

Predictions of an early settlement of the coastwise shipping strike, which has seriously affected this market for some time back, are heard in the trade, but as to the details of the where and when and how, nothing is definite. Small quantities of *rosin* are coming into the local market, but not nearly enough to meet requirements. All grades have been dropped to new levels which will prevail upon the resumption of normal business. *Turpentine* is available in small quantities at $1.92½@$1.95 per gal.

Vegetable Oils

Linseed has been quiet during the week with a slight drop in quotations, with $1.67@$1.70 per gal. as the prevailing figures. Crushers report business at a standstill and can see no improvement for a month at least. The rest of the list is firmly maintained, with very little activity throughout the list.

The Baltimore Market

Baltimore, Md., June 10, 1920.

The fertilizer manufacturers in this section are rapidly winding up the spring season, which has been delayed on account of labor and car shortage. There will be no intermission between seasons on account of the labor situation, and as fast as spring business is being disposed of, they are starting on fall goods.

Comparatively little interest is shown in futures, except for low grade *ammoniates*, such as garbage tankage, which is very scarce and nominally quoted at $8 per unit of ammonia, 10c. per unit of bone phosphate of lime and $1 per unit of potash, c.a.f. Baltimore. Material in good granular condition is well sold up and almost unobtainable. The demand is very heavy due to fall mixtures of *complete fertilizer* being for goods of much lower grade than for the spring season.

Phosphates

Acid Phosphate.—Producers are well sold up for June, July and August and prevailing quotations for run of pile, testing 17 to 18 per cent available phosphoric acid, vary according to tonnage and specific delivery from $18.50 to $19 per ton, basis 16 per cent A.P.A., in bulk, f.o.b. cars Baltimore, with 16 per cent grade being held at 50c. per ton higher. Actual stocks of acid phosphate which producers have on hand are very low, and all manufacturers are experiencing considerable difficulty in securing supplies of phosphate rock. While summer deliveries are usually the lowest of the year, in anticipation of augmented supplies of phosphate rock later on, October-December deliveries are obtainable at 50c. per ton below summer prices, and a fairly important business has already been booked for October-December deliveries.

Nitrogenous Materials

Blood and Tankage.—Little interest is being manifested at prevailing prices, which hold firm at the equivalent of about $8.25 and 10c. basis c.a.f. Baltimore, and manufacturers expect lower prices to rule, as the demand for tankage for feeding purposes is not brisk at present.

Nitrate of Soda.—The market for spot and nearby ranges from $3.80 to $3.85, which is below the actual cost to import, based on the market in Chile, but some resale lots which arrived too late for use during the spring season are available at 10c. to 15c. per hundred less. These, however, have not been of sufficient importance to establish a lower market.

Cyanamide.—Producers are now sold up to March, 1921, and the only material available for delivery between now and that time is resale. Resale lots for early delivery and now en route are being held at $4.75 per unit f.o.b. Baltimore, and deliveries over the balance of the year are obtainable at about $4.65 per unit.

Potassium Salts

Potash.—The Nebraska producers have disposed of their present stock and production to November, 1920, and are holding shipments beginning November and forward at $2.25 per unit f.o.b. Nebraska producing centers. There have been several arrivals during the past week of Alsatian kainit and manure salt, from which resales have been made at $2 per unit, although the most of the manufacturers are taking deliveries and storing the potash for next season's use to guard against a shortage such as existed during the early part of the past season. New prices for July and forward deliveries of the Alsatian and German products have not yet been announced.

The St. Louis Market

St. Louis, Mo., June 8, 1920.

There has been little change in the chemical market during the past two weeks and prices of most chemicals are stationary. The demand continues to be good and local producers report that a gradual resumption of normal production is taking place.

The local railroad situation shows a healthy improvement, especially for shipments to the West and Southwest. Less than carload lots are being accepted by all lines except where shipments are destined for points on connecting lines or large Eastern industrial centers. Carload shipments are moving slowly on account of the congested condition of the freight terminals. The movement of coal is being materially improved and the possibility of further curtailment of production is apparently past.

Acids.—The demand continues to be heavy and prices are unchanged. *Sulphuric* acid is quoted for carload lots at $15@$16 per ton for the 60-deg. grade and $22 per ton for the 66-deg. grade. *Oleum* is quoted at $27.50 per ton. The supply of *muriatic* acid is limited, 18-deg. grade being quoted at $21 per ton in carload lots. *Nitric* acid is quoted in carload lots at $7 per hundred for 36-deg., $8 for 38-deg., $9 for 40-deg., and $10 for 42-deg.

Sodium Bisulphate.—Supply very limited; price unchanged at $4 per hundred.

Phenol.—Demand good and supply plentiful, due to local firm disposing of surplus Government stock. Quotation unchanged at 12c. per lb., in carload lots.

Zinc Oxide.—Local supplies are low and producers are booking orders for third quarter delivery. Quoted at 10c. per lb. in large lots.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	—	$0.65 – $0.75
Acetone	lb.	$0.15 – $0.20	.21 – .22
Acid, acetic, 28 per cent	cwt.	3.50 – 3.75	4.00 – 4.25
Acetic, 56 per cent	cwt.	6.00 – 6.50	8.75 – 9.00
Acetic, glacial, 99½ per cent, carboy	cwt.	15.50 – 16.00	16.50 – 17.50
Boric, crystals	lb.	.15 – .15½	.15½ – .16½
Boric, powder	lb.	.15 – .15½	.15 – .16
Citric	lb.	1.05 – 1.12	1.17 – 1.18
Hydrochloric (nominal)	cwt.	2.00 – 2.50	3.50 – 4.00
Hydrofluoric, 52 per cent	lb.	.12 – .12½	.13½ – .14
Lactic, 44 per cent tech	lb.	.11 – .11½	.12 – .16
Lactic, 22 per cent tech	lb.	.04½ – .05½	.06 – .07
Molybdic, C. P.	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)		—	—
Nitric, 40 deg.	lb.	.06 – .07	.07½ – .08½
Nitric, 42 deg.	lb.	.07½ – .08	.08½ – .09½
Oxalic, crystals	lb.	.55 – .57	.60 – .65
Phosphoric, Ortho, 50 per cent solution	lb.	.14 – .23	.24 – .25
Picric	lb.	.28 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2.25 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	14.00 – 19.00	—
Sulphuric, 60 deg., drums	ton	—	—
Sulphuric, 66 deg., tank cars	ton	23.00 – 25.00	—
Sulphuric, 66 deg., drums	ton	35.00 – 40.00	45.00 – 50.00
Sulphuric, 66 deg., carboys	ton	36.00 – 40.00	50.00 – 55.00
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 – 30.00	37.00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 – 30.00	38.00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 – 35.00	40.00 – —
Tannic, U. S. P.	lb.	1.45 – 1.50	1.55 – 1.60
Tannic (tech.)	lb.	—	.60 – .90
Tartaric, crystals	lb.	—	.80 – .85
Tungstic, per lb. of WO	lb.	—	1.20 – 1.40
Alcohol, Ethyl (nominal)	gal.	5.10 – 5.50	6.00 – 7.00
Alcohol, Methyl, 95%	gal.	—	2.50 – 2.70
Alcohol, Methyl, pure	gal.	—	3.50 – 3.55
Alcohol, denatured, 188 proof (nominal)	gal.	—	1.10 – 1.15
Alcohol, denatured, 190 proof (nominal)	gal.	—	1.05 – 1.10
Alum, ammonia lump	lb.	.04½ – .05	.05½ – .06
Alum, potash lump	lb.	.07½ – .08¾	.09 – .09½
Alum, chrome lump	lb.	.15¼ – .18	.19 – .20
Aluminum sulphate, commercial (nominal)	lb.	.01½ – .02	.02½ – .03½
Aluminum sulphate, iron free	lb.	.02½ – .03	.04 – .04½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .10¾	.11 – .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.32 – .35	.35 – .40
Ammonium carbonate, powder	lb.	.16 – .16½	.17 – .17½
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.16 – .16½	.17 – .18
Ammonium chloride, granular (gray salammoniac)	lb.	.12½ – .13½	.13½ – .14½
Ammonium nitrate	lb.	.08½ – .09½	.10 – .11
Ammonium sulphate	lb.	.07 – .07½	.08½ – —
Amylacetate	gal.	—	5.00 – —
Amylacetate tech	gal.	—	4.75 – 5.25
Arsenic, oxide, lumps (white arsenic)	lb.	.13½ – .14½	.15½ – .16½
Arsenic, sulphide, powdered (red arsenic)	lb.	.23 – .24	—
Barium chloride	ton	150.00 – 160.00	170.00 – 200.00
Barium dioxide (peroxide)	lb.	.21 – .23	.24 – .25
Barium nitrate	lb.	.09½ – .11	.11 – .12
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ – .05	.05½ – .06
Bleaching powder (see calcium hypochlorite)		—	—
Blue vitriol (see copper sulphate)		—	—
Borax (see sodium borate)		—	—
Brimstone (see sulphur, roll)		—	—
Bromine	lb.	.70 – .90	1.00 – 1.05
Calcium acetate	cwt.	3.50 – 3.55	—
Calcium carbide	lb.	.04½ – .04¾	.04¾ – .05½
Calcium chloride, fused, lump	ton	23.00 – 25.00	30.00 – 40.00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02½
Calcium hypochlorite (bleaching powder)	cwt.	4.00 – 4.25	4.50 – 6.50
Calcium peroxide	lb.	—	1.50 – 1.70
Calcium phosphate, monobasic	lb.	—	.75 – .80
Calcium sulphate, pure	lb.	—	.25 – .30
Carbon bisulphide	lb.	.08 – .09	.10 – .11
Carbon tetrachloride, drums	lb.	.11 – .11½	.12 – .15½
Carbonyl chloride (phosgene)	lb.	—	.80 – 1.05
Caustic potash (see potassium hydroxide)		—	—
Caustic soda (see sodium hydroxide)		—	—
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 – .09½	.10 – .10½
Chloroform	lb.	.30 – .35	.36 – .38
Cobalt oxide	lb.	—	2.00 – 2.05
Copperas (see iron sulphate)		—	—
Copper carbonate, green precipitate	lb.	.27 – .28	.29 – .31
Copper cyanide	lb.	—	.65 – .70
Copper sulphate, crystals	lb.	.08 – .09	.09 – .09½
Cream of tartar (see potassium bitartrate)		—	—
Epsom salt (see magnesium sulphate)		—	—
Ethyl Acetate Com. 85%	gal.	1.35 –	1.40 –
Ethy Acetate pure (acetic ether 98% to 100%)		—	1.75 –
Formaldehyde, 40 per cent (nominal)	lb.	.36 – .40	.57 – .65
Fusel oil, ref.	gal.	—	5.25 – 6.00
Fusel oil, crude (nominal)	gal.	—	—
Glauber's salt (see sodium sulphate)		—	—
Glycerine	lb.	—	.26½ – .28½
Iodine, resublimed	lb.	4.30 – 4.35	4.40 – 4.45
Iron oxide, red	lb.	—	.03 – .20
Iron sulphate (copperas)	cwt.	1.50 – 1.75	1.80 – 2.00
Lead acetate, normal	lb.	—	.13½ – .15½
Lead arsenate (paste)	lb.	.11 – .12	.13 – .17
Lead nitrate, crystals	lb.	—	.90 – 1.00
Litharge	lb.	.14 – .15	.15½ – .16
Lithium carbonate	lb.	—	1.50 – —
Magnesium carbonate, technical	lb.	.12 – .14	.15 – .16
Magnesium sulphate, U. S. P.	100 lb.	3.00 – 3.55	4.00 – 4.50
Magnesium sulphate, commercial	100 lb.	—	3.25 – 3.60
Nickel salt, double	lb.	—	.14 – .16
Nickel salt, single	lb.	—	.16 – .18
Phosgene (see carbonyl chloride)		—	—
Phosphorus, red	lb.	.50 – .55	.60 – .65
Phosphorus, yellow	lb.	—	.35 – .37
Potassium bichromate	lb.	.35 – .37	.45 – .46
Potassium bitartrate (cream of Tartar)	lb.	.52 – .56	.57 – .58
Potassium bromide, granular	lb.	.80 – .85	.90 – .95
Potassium carbonate, U. S. P.	lb.	—	.85 – .88
Potassium carbonate, crude	lb.	.21 – .25	.26 – .28
Potassium chlorate, crystals	lb.	$0.15 – $0.16	$0.21 – —
Potassium hydroxide (caustic potash)	lb.	.28 – .29	.31 – .35
Potassium iodide	lb.	—	3.35 – 3.60
Potassium nitrate	lb.	.15 – .17	.19 – .21
Potassium permanganate	lb.	.75 – .80	.85 – .95
Potassium prussiate, red	lb.	.90 – 1.00	1.05 – —
Potassium prussiate, yellow	lb.	.32 – .36	.35 – .36
Potassium sulphate (powdered)	ton	$225.00 – 240.00	—
Rochelle salts (see sodium potas. tartrate)		—	—
Salammoniac (see ammonium chloride)		—	—
Sal soda (see sodium carbonate)		—	—
Salt cake	ton	28.00 – 32.00	—
Silver cyanide (nominal)	oz.	—	1.25 – —
Silver nitrate (nominal)	oz.	—	.74 – .76
Soda ash, light	100 lb.	—	3.50 – 3.60
Soda ash, dense	100 lb.	—	3.55 – 3.65
Sodium acetate	lb.	.08½ – .09	.09½ – .12
Sodium bicarbonate	100 lb.	2.25 – 2.60	2.75 – 3.50
Sodium bichromate	lb.	.32 – .35	.36 – .37
Sodium bisulphate (nitre cake)	ton	7.00 – 7.50	8.00 – 10.00
Sodium bisulphite Powered	lb.	.06 – .06½	.07 – .10½
Sodium borate (borax)	lb.	.09 – .10	.11 – .12
Sodium carbonate (sal soda)	100 lb.	1.60 – 1.80	1.80 – 2.00
Sodium chlorate	lb.	—	.10 – .11
Sodium cyanide, 96-98 per cent	lb.	.24 – .25	.26 – .27
Sodium fluoride	lb.	.18 – —	.19 – .20
Sodium hydroxide (caustic soda)	100 lb.	4.25 – 6.00	6.25 – 6.50
Sodium hyposulphite	lb.	—	.03 – .04
Sodium molybdate	lb.	2.50 – —	3.25½ – —
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite	lb.	.19 – .19½	.20 – .21
Sodium peroxide, powdered	lb.	.32 – .35	.35 – .40
Sodium phosphate, dibasic	lb.	.03½ – .04½	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	—	.39 – .40
Sodium prussiate, yellow	lb.	.23 – .27	.31 – .32
Sodium silicate, solution (40 deg.)	lb.	.01½ – .02	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.04 – .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.60 – 1.70	1.75 – 2.50
Sodium sulphide, crystal, 60–62 per cent (cone)	lb.	.09 – .10	.10½ – .11
Sodium sulphite, crystals	lb.	.03½ – —	.04 – .06
Strontium nitrate, powdered	lb.	.17½ – .18½	.19 – .20
Sulphur chloride	lb.	.05½ – —	.06 – —
Sulphur, crude	ton	22.00 – —	—
Sulphur dioxide, liquid, cylinders	lb.	.09 – —	.10 – .12
Sulphur (sublimed), flour	100 lb.	3.35 – —	3.40 – 3.65
Sulphur, roll (brimstone)	100 lb.	3.20 – —	3.30 – 3.40
Tin bichloride (stannous)	lb.	.42½ – —	.46 – .50
Tin oxide	lb.	.60 – .63	.65 – —
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran.	lb.	.13 – —	.13½ – .17
Zinc cyanide	lb.	.49 – —	.50 – .60
Zinc dust	lb.	.12¼ – —	.13 – .15
Zinc oxide, U. S. P.	lb.	.18 – .19	.20 – .21
Zinc sulphate	lb.	.03¼ – .03½	.04 – .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.40 —	$1.50
Alpha naphthol, refined	lb.	1.60 —	1.70
Alpha naphthylamine	lb.	.65 —	.70
Aniline oil, drums extra	lb.	.35 —	.40
Aniline salts	lb.	.42 —	.50
Anthracine, 80% in drums (100 lb.)	lb.	.90 —	1.00
Benzaldehyde (f.f.c.)	lb.	2.00 —	2.10
Benzidine, base	lb.	1.35 —	1.40
Benzidine, sulphate	lb.	1.15 —	1.25
Benzoic acid, U.S.P.	lb.	.90 —	1.00
Benzoate of soda, U.S.P.	lb.	.80 —	.90
Benzol, pure, water-white, in drums (100 lb.)	gal.	.27 —	.30
Benzol, 90%, in drums (100 lb.)	gal.	.25 —	.31
Benzyl chloride, 95-97%, refined	lb.	.35 —	.40
Benzyl chloride, tech	lb.	.25 —	.35
Beta naphthol benzoate (nominal)	lb.	.50 —	.60
Beta naphthol, sublimed (nominal)	lb.	.80 —	.90
Beta naphthol, tech (nominal)	lb.	.65 —	.80
Beta naphthylamine, sublimed	lb.	2.25 —	2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18 —	.19
Ortho-cresol, in drums (100 lb.)	lb.	.23 —	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	1.10 —	1.20
Cresylic acid, 95-97%, dark, in drums	gal.	1.00 —	1.05
Cresylic acid, 50%, first quality, drums	gal.	.65 —	.75
Dichlorbenzol	lb.	.08 —	.10
Diethylaniline	lb.	1.40 —	1.50
Dimethylaniline	lb.	1.25 —	1.50
Dinitrobenzol	lb.	.30 —	.32
Dinitroclorbenzol	lb.	.30 —	.35
Dinitronaphthaline	lb.	.45 —	.55
Dinitrophenol	lb.	.40 —	.45
Dinitrotoluol	lb.	.40 —	.45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 —	.40
Diphenylamine (nominal)	lb.	.80 —	.85
H-acid (nominal)	lb.	2.25 —	2.50
Metaphenylenediamine	lb.	1.15 —	1.30
Monochlorbenzol	lb.	.18 —	.20
Monoethylaniline	lb.	2.00 —	2.40
Naphthaline crushed, in bbls. (250 lb.)	lb.	.15 —	—
Naphthaline, flake	lb.	.15½ —	.17
Naphthaline, balls	lb.	.16 —	.18
Naphthionic acid, crude	lb.	.75 —	.85
Nitrobenzol	lb.	.14 —	.19
Nitro-naphthaline	lb.	.40 —	.50
Nitro-toluol	lb.	.18 —	.25
Ortho-amidophenol	lb.	3.25 —	4.25
Ortho-dichlor-benzol	lb.	.15 —	.20
Ortho-nitro-phenol	lb.	.80 —	1.25
Ortho-nitro-toluol	lb.	.25 —	.40
Ortho-toluidine	lb.	.35 —	.45
Para-amidophenol, base	lb.	2.50 —	3.50
Para-amidophenol, HCl	lb.	2.50 —	3.25
Para-dichlor-benzol	lb.	.08 —	.12
Paranitraniline	lb.	—	1.65
Para-nitro-toluol	lb.	1.35 —	1.50
Paraphenylenediamine	lb.	2.60 —	3.00
Paratoluidine	lb.	2.00 —	2.50
Phthalic anhydride	lb.	.65 —	.75
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12 —	.20
Pyridin	gal.	2.00 —	3.50
Resorcin, technical	lb.	4.25 —	4.50
Resorcin, pure	lb.	6.25 —	6.75

Salicylic acid, tech., in bbls. (110 lb.)	lb.	$0.50 —	$0.52
Salicylic acid, U. S. P.	lb.	.50 —	.60
Salol	lb.	.90 —	1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 —	.31
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19 —	.24
Sulphanilic acid, crude	lb.	.28 —	.32
Toluidine	lb.	1.70 —	2.50
Toluidine, mixed	lb	.45 —	.55
Toluol, in tank cars	gal.	.28 —	.....
Toluol, in drums	gal.	.29 —	.32
Xylidine, drums, 100 gal.	lb.	.44 —	.50
Xylol, pure, in drums	gal.	.37 —	.45
Xylol, pure, in tank cars	gal.	.35 —	.....
Xylol, commercial, in drums, 100 gal.	gal.	.37 —	.45
Xylol, commercial, in tank cars	gal.	.23 —	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.36 —	$0.39
Beeswax, refined, light	lb.	.39 —	.40
Beeswax, white pure	lb.	.63 —	.68
Carnauba, No. 1 (nominal)	lb.	1.00 —	1.05
Carnauba, No. 2, regular (nominal)	lb.	.85 —	.88
Carnauba, No. 3, North Country (nominal)	lb.	.43 —	.44
Japan	lb.	.21 —	.22
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09½ —	.10
Paraffine waxes, crude, scale 124-126 m.p.	lb.	..... —	.10
Paraffine waxes, refined, 118-120 m.p.	lb.	.11½ —	.12½
Paraffine waxes, refined, 128-130 m.p.	lb.	.13 —	.13½
Paraffine waxes, refined, 133-135 m.p.	lb.	.15½ —	.16½
Paraffine waxes, refined, 135-137 m.p.	lb.	.17½ —	.18½
Stearic acid, single pressed	lb.	.25 —	.26
Stearic acid, double pressed	lb.	.26 —	.27
Stearic acid, triple pressed	lb.	.28 —	.29

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.80
Pine oil, pure, dest. dist.	gal.	1.60
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$17.50 —	$18.00
Rosin E-I	280 lb.	18.50 —	19.75
Rosin K-N	280 lb.	20.00 —	21.00
Rosin W. G.-W. W.	280 lb.	21.25 —	23.00
Wood rosin, bbl.	280 lb.	17.00 —	17.00
Spirits of turpentine	gal.	1.00 —	1.52
Wood turpentine, steam dist.	gal.	1.75 —	1.85
Wood turpentine, dest. dist.	gal.	1.45 —	1.55
Pine tar pitch, bbl.	200 lb.	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50 —	15.00
Retort tar, bbl.	500 lb.	15.00 —	15.50
Rosin oil, first run	gal.	.87 —	.89
Rosin oil, second run	gal.	.89 —	.92
Rosin oil, third run	gal.	1.04 —	1.05
Rosin oil, fourth run	gal.	1.12 —	1.12

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal.	.38
68-70 deg., steel bbls. (85 lb.)	gal.	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.29

Crude Rubber

Para—Upriver fine	lb.	$0.37½ —	$0.38
Upriver coarse	lb.	.28½ —	.29½
Upriver caucho ball	lb.	.30 —	.30½
Plantation—First latex crepe	lb.	.38 —	.39
Ribbed smoked sheets	lb.	.38½ —	.39
Brown crepe, thin, clean	lb.	.37 —	.38
Amber crepe No. 1	lb.	..... —	.40

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.18½ —	$0.20
Castor oil, AA, in bbls.	lb.	.20 —	.22
China wood oil, in bbls.	lb.	.22½ —	.23½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.17½ —	.18½
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.18½ —	.19½
Corn oil, crude, in bbls.	lb.	.17½ —	.18
Cottonseed oil, crude (f.o.b. mill)	lb.	.15½ —	.16
Cottonseed oil, summer yellow	lb.	.19 —	.19½
Cotconseed oil, winter yellow	lb.	.21 —	.22
Linsed oil, raw, car lots (domestic)	gal.	1.67 —	.....
Linseed oil, raw, tank cars (domestic)	gal.	1.62 —	.....
Linseed oil, boiled, car lots (domestic)	gal.	1.70 —	.....
Olive oil, commercial	gal.	3.10 —	3.25
Palm, Lagos	lb.	.12½ —	.13½
Palm, bright red	lb.	.13 —	.13½
Palm, Niger	lb.	.11 —	.12
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.15½ —	.16½
Peanut oil, refined, in bbls.	lb.	.22 —	.24
Rapeseed oil, refined in bbls.	gal.	1.70 —	1.72
Rapeseed oil, blown, in bbls.	gal.	1.80 —	1.85
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.17 —	.18
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.12½ —	.13½

FISH

Winter pressed Menhaden	gal.	$1.17 —	$1.18
Yellow bleached Menhaden	gal.	1.20 —	1.22
White bleached Menhaden	gal.	1.23 —	1.24
Blown Menhaden	gal.	1.30 —	1.32

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$20.00 —	$22.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	16.00 —	18.00
Barytes, crude, 88% @ 94% ba., Kings Creek	net ton	8.00 —	10.00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23.00 —	25.00
Barytes, ground, off-color, f.o.b. Cartersville	net ton	16.00 —	19.00
Barytes, crude, 88% @ 94% ba., Cartersville	net ton	12.00 —	.....
Blanc fixe, dry	lb.	.05½ —	.06
Blanc fixe, pulp	net ton	60.00 —	80.00
Casein	lb.	.15 —	.18
Chalk, English, extra light	lb.	.05 —	.07
Chalk, English, light	lb.	.05 —	.06
Chalk, English, dense	lb.	.04½ —	.05
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00 —	40.00
China clay (Kaolin), imported, lump	net ton	25.00 —	35.00
China clay (Kaolin), imported, powdered	net ton	30.00 —	60.00
Feldspar (nominal) f.o.b. N. Y. State	net ton	16.00 —	20.00
Feldspar, crude, f.o.b. Maryland and North Carolina, points	net ton	7.50 —	8.00
Feldspar, ground, f.o.b. Baltimore	net ton	18.00 —	25.00
Feldspar, ground, f.o.b. North Carolina	net ton	16.00 —	20.00
Fuller's earth, domestic, powdered	net ton	25.00 —	30.00
Fuller's earth, imported, powdered	net ton	35.00 —	40.00
Graphite (dust polish grade 30%) Ashland, Ala.	lb.	..... —	.01
Graphite (dust facing grade 50%) Ashland, Ala.	lb.	..... —	.02
Graphite, crucible, 80% carbon Ashland, Ala.	lb.	..... —	.05
Graphite, crucible, 90% carbon Ashland, Ala.	lb.	..... —	.10
Graphite, crucible, 85% carbon	lb.	..... —	.08
Graphite, crucible, 88% carbon	lb.	..... —	.09½
Graphite, crucible, 90% carbon	lb.	..... —	.10½
Pumice stone, imported	lb.	.03 —	.06
Pumice stone, domestic	lb.	.02½ —	.....
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	..... —	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore	net ton	..... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	..... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange, fine nominal	lb.	1.50 —	.....
Shellac, orange, superfine	lb.	1.30 —	1.40
Shellac, A. C. garnet	lb.	1.05 —	1.10
Shellac, T.N.	lb.	1.10 —	1.20
Soapstone	ton	15.00 —	25.00
Talc, paper-making grades, f.o.b. Vermont	ton	9.50 —	14.00
Talc, roofing grades, f.o.b. Vermont	ton	8.00 —	9.00
Talc, rubber grades, f.o.b. Vermont	ton	9.00 —	15.00
Talc, powdered, Southern, f.o.b. cars	ton	12.00 —	15.00
Talc, talcum powder grade, California	ton	20.00 —	35.00
Talc, imported	ton	60.00 —	70.00

Refractories

Following prices are f.o.b. Works:

Chrome brick	net ton	$75-80 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	1,000	45-50 at Clearfield, Penn.
Clay brick, 2nd quality	1,000	40-45 at Clearfield, Penn.
Fire clay, f.o.b. Baltimore	net ton	5—7
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	85-90 at Chester, Penn.
Silica brick	1,000	50-55 at Mt. Union, Penn.

Ferro-Alloys

All Prices f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.17 —	.18
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon	lb.	.18 —	.19
Ferro-manganese, 70-80% Mn	gross ton	200.00 —	250.00
Spiegeleisen, 16-20% Mn	gross ton	72.50 —	75.00
Ferro-molybdenum, per lb. of Mo	lb.	2.25 —	2.75
Ferro-silicon, 50%	gross ton	80.00 —	90.00
Ferro-silicon, 75%	gross ton	150.00 —	160.00
Ferro-silicon, 10-15%	gross ton	60.00 —	65.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	.90 —	1.10
Ferro-uranium, 35-50%, of U, per lb. of U content	lb.	7.00 —	.....
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50 —	7.75

Ores and Semi-finished Products

All Prices f. o. b. Mines

Chrome ore, 35-40%, Cr_2O_3 f.o.b. Atlantic Seaboard	unit	$0.70 —	$0.85
Coke, foundry, f.o.b. ovens	net ton	15.00 —	15.50
Coke, furnace, f.o.b. ovens	net ton	14.50 —	15.00
*Petroleum coke, refinery, Atlantic seaboard	net ton	..... —	24.00
Fluor spar, gravel, f.o.b. mines	net ton	25.00 —	30.00
*Fluor spar, acid grade, lump, f.o.b. Tonuco, Mex.	net ton	30.00 —	45.00
*Fluor spar, acid grade, ground, f.o.b. Tonuco	net ton	55.00 —	65.00
Manganese ore, 45% Mn and over	unit	.80 —	.85
Manganese ore, chemical (MnO_2)	gross ton	80.00 —	90.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.85 —	.....
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00 —	.....
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	6.50 —	7.50
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75 —	3.00
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium Ore per lb. of V contained	lb.	1.00 —	3.00
Pyrites, foreign, lump, per unit of S contained	unit	.16½ —	.....
Pyrites, foreign, fine, per unit of S contained	unit	.16½ —	.....
Pyrites, domestic, fine, per unit of S contained	unit	.16 —	.17½
Ilmenite, 52% TiO_2, per lb. ore	lb.	.02 —	.....
Rutile, 95% TiO_2 per lb. ore	lb.	.20 —	.25
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75 —	3.00
Zircon, washed, iron free	lb.	.10 —	.....
Monazite, per unit of ThO_2	unit	42.00 —	.....

*Nominal

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arizona

CASA GRANDE—The School Bd. has awarded the contract for the construction of a 3-story Class C high school here, to Jay J. Garfield, Miami, Ariz., at $117,958. A chemical laboratory will be installed in same.

California

LOS ANGELES—The Schultheiss Mfg. Co., Boyle Ave., is building a plant on Slanson Ave. for the manufacture of plumbing supplies, to include a 50x225-ft. factory, 20x45-ft. core room, 20x35-ft. coaling room, office, etc.

GLENDALE—The Glendale Sanitarium has engaged Olmsted & Gillelen, 1112 Hollingsworth Bldg., Los Angeles, to prepare plans for the construction of a septic tank sewer system, in connection with the proposed group of hospital buildings at B'way and Jackson Ave.

District of Columbia

WASHINGTON—The Bureau of Yards & Docks, Navy Dept., will receive bids until June 21 for improvements to the laboratory here. C. W. Parks, chief of bureau.

Florida

DAYTONA BEACH—The town plans to construct a water-softening plant in connection with the waterworks system here. H. E. Pence offered $10,000 for the project.

HASTINGS—The McGuire Fertilizer & Phosphate Co. plans to construct an acid chamber and mixing plant, etc., here. C. L. Brown, agt.

JACKSONVILLE—The Wilson & Toomer Fertilizer Co., Talleyrand Ave., has obtained a permit from the city to construct a fertilizer factory here. Estimated cost, $75,000.

Georgia

ROME—The International Steel & Motors Corp. plans to build an immense plant here, for the manufacture of standard machinery and standard automobile parts. A blast furnace with 60-ton daily capacity will be constructed in the near future at the company's ore lands north of here. An open-hearth furnace with blooming mill for making hard and soft billets, with an annual capacity of 200,000 tons, will be constructed later, together with a bar and sheet mill.

Illinois

CHICAGO—The Central Steel & Wire Co., 127 North Peoria St., plans to build a large foundry on the southeast corner of Western Ave. and 45th Pl. Estimated cost, $450,000.

GALVA—Clark Aby, city attorney, will receive bids until June 24 for the construction of 2 sewer systems with disposal plants.

Indiana

FORT WAYNE—The General Electric Co., B'way and the Pennsylvania Ry., has awarded the contract for the construction of a 2- and 3-story, 150x300-ft. lamp works on Winter St., to Edward M. Waldron, Inc., 665 Broad St., Newark, N. J. Estimated cost, $400,000.

INDIANAPOLIS — The Westinghouse Lamp Co., 165 B'way, has purchased a site here and plans to construct an electric bulb plant on same. Estimated cost, $2,500,000.

Iowa

BURNSIDE — The Consolidated School Dist. will soon award the contract for the construction of a 2-story, 57x89-ft. consolidated school here. A chemical laboratory and septic tank, etc., will be installed in same. Ed. Midendorf, secy. W. E. Hulse Co., 309-10 Securities Bldg., Des Moines, archt.

CLIMAX—The School Bd. will probably install a chemical laboratory in the proposed school here. William Gordon, 317 Hubbell Bldg., Des Moines, archt.

CORYDEN—The School Bd. is having plans prepared for the construction of a 3-story, 66x121-ft. school building. A chemical laboratory will be installed in same. Estimated cost, $135,000. D. S. Sullenberger, pres. W. Gordon, 319 Hubbell Bldg., Des Moines, archt.

MARTINSDALE—The Consolidated School Dist. has awarded the general contract for the construction of a 2-story consolidated school, to Cork & Farrier. A chemical laboratory will be installed in same.

McCALLSBURG—The School Bd. will receive bids until July 8 for the construction of a 60x100-ft. school building. A chemical laboratory will be installed in same. Estimated cost, $110,000. W. L. Pidicord, Iowa Falls, archt.

PATON—The Consolidated School Dist. has issued bonds for the construction of a consolidated school. A chemical laboratory will be installed in same. J. Miller, secy. W. E. Hulse Co., 309 Securities Bldg., Des Moines, archt.

POCAHONTAS—W. J. Gilchrist, Pres. of the School Bd., will receive bids until June 25 for the construction of a 2-story, 56x110-ft. school building. A chemical laboratory will be installed in same. Estimated cost, $150,000. W. E. Hulse Co., 309 Securities Bldg., Des Moines, archt.

STENNETT—The Bd. Educ., Consolidated School Dist., has awarded the general contract for the construction of a consolidated school, to the Garmer-Stiles Co., 425 Flynn Bldg., Des Moines. A chemical laboratory will be installed in same.

Kansas

PAOLA—The city clerk will receive bids until June 22 for furnishing material and labor necessary to construct a water filtration plant, including a filter house, coagulating basin, clear well, etc. Black & Veatch, Interstate Bldg., Kansas City, Mo., engrs.

SCOTT CITY—The city has awarded the contract for the construction of a sanitary sewer system and sewage disposal plant, to M. R. Ammerman, Box 222, Wichita, at $76,381.

Kentucky

LOUISVILLE — The Illinois Malleable Iron Co., 1801 Diversey Blvd., Chicago, had plans prepared for the construction of a large building here.

Maryland

BALTIMORE—The Baltimore Brick Co., Maryland Trust Bldg., will build a 1-story, 28x116-ft. machine shop at Highland Ave. and Monument St. Estimated cost, $5,000. Work will be done by day labor.

Massachusetts

BOSTON—The Boston Paper Bd. Co., 161 Albany St., will build a 4-story, 40x50-ft. addition to plant on Albany St. Estimated cost, $25,000. Work will be done by day labor.

BOSTON—The city is having plans prepared for the construction of a 3-story, 150x300-ft. school on Avenue Louis Pasteur. Chemical equipment will be installed in same. Estimated cost, $1,200,000. J. E. McLaughlin, 88 Tremont St., archt.

BOSTON—The Metropolitan Lithographing & Publishing Co., Dane St., has awarded the contract for the construction of a 1-story, 50x162-ft. manufacturing plant on Bow St., to the Hudson Constr. Co., 6 Beacon St. Estimated cost, $50,000.

FLORENCE—The International Silver Co., 48 State St., Meriden, Conn., has awarded the contract for the construction of a 1-story, 40x110-ft. forge shop and altering the present building, to J. H. Grozier Co., 721 Main St., Hartford, Conn. Estimated cost, $45,000. Noted May 26.

Missouri

ST. LOUIS—The Laclede Gas Light Co., 10th and Olive Sts., has awarded the contract for the construction of 8 coke ovens at 518 Catalan St., to Paul Goffort, at $80,000.

ST. LOUIS—The Lutheran Hospital, 3500 Ohio Ave., is having plans prepared for the construction of a 5-story, 40 x 120-ft. hospital addition. A completely equipped laboratory will be installed in same. Estimated cost, $125,000. H. J. Burgdorf, 2604 Virginia Ave., archt.

New York

BUFFALO—The Bancroft Jones Corp., Mutual Life Bldg., plans to build an 80x200-ft. fabricating plant at 60 Hubbard St. Estimated cost, $15,000.

BUFFALO—The Director of the New York State Institute for the Study of Malignant Diseases, 113 High St., will receive bids until July 1 for furnishing anhydrous radium bromide containing 50 to 70 per cent of radium element.

BUFFALO—The Roquemore Cast Stone Co., 2851 Delaware Ave., Kenmore, plans to build a 1-story, 28x44-ft. factory to manufacture concrete products near the New York Central R.R. tracks between Breckenridge and Ferry Sts. Estimated cost, $11,000.

LOCKPORT—The Upsom Co., manufacturer of wall board, has filed plans to build a 1-story, 72 x 170-ft. factory addition to its plant on Bristol Ave. Estimated cost, $35,000.

NIAGARA FALLS—The Carborundum Co., Buffalo Ave. and 11th St., has filed plans with the building comr. to repair fire damage to its building. Estimated cost, $50,000.

NIAGARA FALLS — The International Paper Co., Buffalo Ave. and 13th St., plans to build an addition to its factory here. Estimated cost, $65,000.

RICHMOND HILL—R. M. Krauser, c/o C. Bauer, archt., 788 Manhattan Ave., Brooklyn, is having plans prepared for the construction of a 3-story, 60x100-ft. factory for the manufacture of gold seals, on 129th St. Estimated cost, $80,000.

SYRACUSE—The city plans to construct a sewage disposal plant here next spring.

Ohio

CINCINNATI—The Lunkenheimer Co., Beekman & Tremont Sts., has awarded the contract for the construction of a 1-story, 350x400-ft. foundry on Carthage St., to the Fisher Devore Constr. Co., Blymer Bldg. Estimated cost, $100,000.

CINCINNATI — The Peerless Foundry Co., Township Ave., has awarded the contract for the construction of a 1-story, 120x120-ft. foundry, to the Ferro Concrete Constr. Co., Richmond and Harriet Sts. Estimated cost, $40,000.

CLEVELAND—Walter Nathan, 1383 East Boulevard, has awarded the contract for the construction of a 3-story, 46x108-ft. factory addition at 6203 Cedar Ave., to William Dunbar Co., 8201 Cedar Ave. Central Brass Mfg. Co., 6203 Cedar Ave., lessee.

CLEVELAND — The Strong Cobb Co. plans to build a 2-story factory for the manufacture of drugs. Estimated cost, $150,000.

EAST CLEVELAND (Cleveland P. O.) —The Natl. Lamp Co. of the General Electric Wks., Nela Park, has awarded the contract for the construction of a 1-story, 55x110-ft. laboratory at Nela Park, to the Heller Bros., Youngstown. Estimated cost, $100,000.

ELYRIA—H. A. Beck, Dir. of Pub. Serv., will receive bids until June 21 for the construction of a filtration plant, substructures and appurtenant works, including coagulating basin, filtered water reservoir and rapid sand filter tanks, etc. Noted April 14.

HURON—The Universal Steel Co., 408 Schofield Bldg., Cleveland, has purchased a site and plans to build a 1-story, 78x500-ft. tube and conduit mills, on same. Estimated cost, $300,000. F. W. Metler, gen. mgr.

IRONTON—The Sheridan Coal Co. plans to construct a brick manufacturing plant including ovens, kilns, pulverizing machinery, etc., at Sheridan near here. Estimated cost, $175,000.

LIMA—The Bd. Educ. will receive bids until June 15 for the construction of a 2-story, 82x124-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $123,000. McLaughlin & Hulsken, Savings Bldg., archts.

STOUTSVILLE—The city received bids for the construction of a sewage disposal plant for school building from the Stout Bros., $5,150; Taylor & Linn, Zanesville, $5,500.

XENIA—The city will soon award the contract for the construction of a 1,000,000-gal. water purification plant, etc. Kenyon Riddle, city mgr.

Oklahoma

PURCELL — The Legislative Council have engaged Johnson & Benham, consult. engrs., 150 Nassau St., New York City, to prepare plans and submit estimates for the construction of an impounding reservoir, intake works, modern filtration and sterilization plant.

Oregon

PORTLAND—The Pub. Dock Comn. will soon award the contract for furnishing $75,000 worth of phosphate handling machinery and 3,900 ft. of 30-in. conveyor belting for same. G. B. Hegardi, engrs.

Pennsylvania

McKEESPORT—The Columbiana Fdry. Co., House Bldg., Pittsburgh, is building a 100x300-ft. foundry and a 40x140-ft. office and pattern shop. Estimated cost, $250,000.

Rhode Island

PAWTUCKET—The Pawtucket Hosiery Co., 107 Rand St., Central Falls, has awarded the contract for the construction of a 1-story, 32x75-ft. textile mill, to the Humes Constr. Co., 76 Dorrance St., Providence. Estimated cost, $15,000.

South Carolina

COLUMBIA—The Colon Ry. Gas & Electric Co., Arcade Bldg., plans to expand present gas plant by building tanks, etc., to provide for several hundred thousand more cu.ft. of gas. Estimated cost, $400,000. J. G. White Eng. Corp., 43 Exch. Pl., New York City, engr.

Tennessee

MEMPHIS—The Memphis Steel & Iron Works plans to build a rolling mill in the northern part of the city. Equipment will be installed in same. Estimated cost, $300,000. J. E. Conley, pres.

Texas

BRECKENRIDGE — The Breckenridge Oil & Refining Co. is having plans prepared for the construction of an oil refinery to turn out gasoline, kerosine, lubricating oils and other refined oil products. The plant will have a 1,000 bbl. daily capacity. Estimated cost, $300,000.

FARMERSVILLE—The Bd. of Directors of the Farmersville Sewer Co. will soon award the contract for the construction of sanitary sewer lines and 2 sewage disposal plants. J. E. Worden, treas.

FORT WORTH—The Physicians & Surgeons Hospital is having plans prepared for the construction of a 4-story hospital on B'way Blvd. Complete surgical equipment will be installed in same. Estimated cost, $300,000. Sauguinet & Staats, 1st Natl. Bank Bldg., archts.

WHITESBORO—Harry Reast, secy., will soon award the contract for the furnishing of all labor and material for the construction of a sanitary sewer system and disposal plant.

Vermont

BRATTLEBORO — The C. F. Church Mfg. Co., Willimansett, Mass., has awarded the contract for the construction of three buildings including a 1-story main building, 1-story dry kiln, etc., to E. F. Carlson Co., 244 Main St., Springfield, Mass. Estimated cost, $80,000.

Virginia

RICHMOND — The Virginia Carolina Rubber Co., Real Estate Exch. Bldg., will soon award the contract for the construction of 50x240-ft. building for the manufacture of tires, etc. Estimated cost, $15,000. J. T. Waddell, engr.

WINCHESTER—The Harloe Tire Co., St. James Hotel, Wash., D. C., plans to construct a building. Estimated cost, $150,000. Address Mr. King.

Wisconsin

FOND DU LAC—The Bd. Educ. is having plans prepared for the construction of a 2-story junior high school. A chemical laboratory will be installed in same. Estimated cost, $300,000. Childs & Smith, 64 East Van Buren St., Chicago, archts.

MADISON—The State appropriated $25,000 for the installation of additional toilet facilities on the state fair grounds, the construction and equipment of necessary buildings, a septic tank and equipment and for the construction of necessary extensions of water mains and sewers.

MADISON—The state appropriated $90,700 for the construction and equipment of the upper three floors of the west wing of the Chemistry Building here.

MANITOWOC—H. Zannacker & Sons, 923 Washington Ave., will receive bids until June 18 for the construction of a 3-story, 50x64-ft. dry cleaning building on 18th St.

WATERLOO—The village will receive bids until July 1 for the construction of sanitary sewers and septic tanks. W. J. Higgins, clk.

Ontario

HAMILTON—The Mercury Mills, Ltd., has awarded the contract for the construction of a 4-story, 50x260-ft. dye house on Cumberland Ave., to W. H. Cooper, Clyde Block. Estimated cost, $150,000.

Quebec

LAPRAIRIE—The Interprovincial Clay Products Co. of Canada, Ltd., a subsidiary company of the Interprovincial Brick Co., will soon receive bids for the construction of a plant and the installation of equipment.

MONTREAL—The Barrett Mfg. Co., 2021 St. Hubert St., has awarded the contract for the construction of a 2-story, 38x54-ft. roofing manufacturing building on Boyer St., to the Sheaver Co., 277 St. Patricks St., at $18,500. Noted April 14.

MONTREAL—The Canadian Con. Rubber Co., 201 Inspector St., has awarded the contract for the construction of a 100x150-ft. rubber goods factory at Guy and St. James St., to Lockwood, Greene & Co., 285 Beaver Hall, at $100,000.

OTTAWA—The Gatineau Co., Ltd., plans to construct pulp and paper mills, 3 dams, etc., in the Gatineau Valley Dist. Estimated cost, $30,000,000. C. B. Thorne, Montreal, engr.

Coming Meetings and Events

THE AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

THE AMERICAN DROP FORGE ASSOCIATION will hold its seventh annual convention at the Marlborough-Blenheim Hotel, Atlantic City, N. J., June 17, 18 and 19.

THE AMERICAN ELECTROPLATERS' SOCIETY will hold its eighth annual convention in Rochester, June 30 to July 3. Headquarters will be at the Seneca Hotel.

THE AMERICAN FOUNDRYMEN'S ASSOCIATION will meet in Columbus, Ohio, Oct. 4 to 8 inclusive.

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its twelfth semi-annual meeting as follows: June 28 and 29 will be spent in Montreal, June 30 in Ottawa, July 1 in Ontario, July 2 in Shawinigan Falls, July 3 in La Tuque, July 4 in Chicoutimi and July 5 in Quebec.

THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its one hundred and twenty-second meeting Aug. 20 to Sept. 3, at Lake Superior.

THE AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

THE AMERICAN SOCIETY FOR TESTING MATERIALS will hold its annual meeting at the New Monterey Hotel, Asbury Park, N. J., June 22 to 25.

THE AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

THE FOREST PRODUCTS LABORATORY will hold its decennial celebration at Madison, Wis., July 22 and 23, 1920.

THE INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

THE INSECTICIDE AND DISINFECTANT MANUFACTURERS' ASSOCIATION will hold its mid-summer meeting at Boston, July 15 and 16.

THE IRON AND STEEL INSTITUTE (British) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

THE SIXTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

THE NATIONAL FERTILIZER ASSOCIATION will hold its twenty-seventh annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 21.

THE ILLINOIS MINING INSTITUTE will meet in Chicago, June 23 to 26.

THE STEEL BARREL MANUFACTURERS' ASSOCIATION will meet in Chicago, June 24.

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION will hold its twenty-seventh annual meeting June 29 to July 3, at the University of Michigan, Ann Arbor, Mich.

THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall meeting at Saratoga Springs, N. Y., Sept. 1, 2 and 3.

Industrial Notes

SIDNEY CORNELL, chemical and industrial engineer, has moved his office from 1 West 34th St. to 80 Maiden Lane, New York City.

METALLURGICAL RESEARCH ENGINEERING Co. has moved its office to 427 Reaper Blk., corner of Clark and Washington Sts., Chicago, Ill.

INDIANAPOLIS CHAMBER OF COMMERCE BUREAU OF INDUSTRY has prepared a large map of the City of Indianapolis showing vacant factory sites that are available, street-car service, transportation and all physical features that enter into the selection of industrial sites.

THE U. S. COPPER PRODUCTS CORP. of Cleveland, Ohio, announces the opening of a New York City office at 1123 Broadway, for the sale of seamless brass and copper tubes. This branch will be under the management of Herbert Gnad.

THE GILLESPIE EDEN CORP. is the name of the consolidation of the Gillespie Manufacturing Co., the Gillespie Motor Co., the Gillespie Foundry Co. and the Brokaw-Eden Co. Executive offices are at 50 Church St., New York City.

THE CUTLER-HAMMER MFG. CO., Milwaukee, Wis., announces that the Chicago offices have been removed from the People's Gas Bldg. to the company's own building, 323 No. Michigan Ave. H. L. Dawson is manager.

THE GENERAL CERAMICS CO., 50 Church St., New York City, has established an engineering department at 145 West 45th St., New York City. P. C. Kingsbury is chief engineer of this branch office.

THE STEARNS-ROGER MFG. CO., Denver, with which W. C. Graham of the Great Western Sugar Co. and W. G. Haldane, formerly president of the Colorado School of Mines, are associated as consulting engineers, has taken a contract for the improvement of the processes and practice of the American Potash Co. at Antioch, Neb. The Stearns-Roger organization is one of the few that have specialized in the production of potash from lake waters, and has succeeded in solving some of the difficult problems encountered in this comparatively new industry.

THE MERRILL CO., of San Francisco, has transferred the manufacture of the Nordstrum valve from San Francisco to the plant of the Swenson Evaporator Co. at Chicago.

THE WISHNICK-PUMPEER CHEMICAL CO. has been organized with offices and warehouse at North Pier Terminal, 365 East Illinois St., Chicago, for handling chemicals, oils and colors. The members of the firm are Robert Wishnick, David Pumpeer and Julius Pumpeer, all formerly connected with A. Daigger & Co., Chicago.